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DIATHERMIC SURGERY OF THE CILIARY BODY IN GLAUCOMA*

EXPERIMENTAL AND CLINICAL OBSERVATIONS

MANUEL URIBE TRONCOSO, M.D.
New York

HISTORY

Shahan and Post[1] in 1921 were the first to apply heat to the limbus by means of the thermophore in order to obtain a reduction of the intraocular pressure. They used rabbits' eyes and 40 human eyes affected with glaucoma. Curran[2] (1925) devised an operation which consisted in cauterizing the sclera with the galvano-cautery near the limbus, over an area 8 to 10 mm. in diameter. His purpose was, first, to interfere with the function of the ciliary body at the place of cauterization and, second, to produce a decompression staphyloma. He succeeded in lowering the intraocular pressure, but the effect was temporary. Fiore[3] in 1929 reported at the International Congress of Ophthalmology in Amsterdam the results of an operation with the galvano-cautery in which the sclera and ciliary body were perforated several times. He made linear applications in a meridional direction from the limbus to the ora serrata. His idea was, first, to make a destructive coloboma of the ciliary body and reduce edema; and, second, to cut the ciliary muscle ring and allow a freer flow of the intraocular fluids. According to the author, the operation was performed with success on 177 eyes, the majority of which were affected with acute glaucoma.

Vogt[4] in 1937 for the first time applied diathermy to the ciliary body with the object of obtaining a reduction of the intraocular pressure in glaucoma. He called this method "cyclodiathermy." The operation consisted of a great number of transcleral punctures (usually 100 or more) made with a special small needle, 0.5 mm. long and 0.18 mm. thick, provided with a stop and using about 60 milliamperes (fig. 1). The needle was pushed vertically into the sclera at intervals of

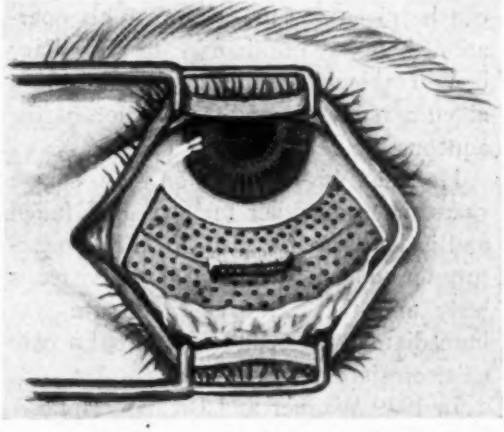

Fig. 1. Vogt's operation for cyclodiathermy. The severed tendon of the inferior rectus muscle is in the center of the coagulated area.

* From the Department of Ophthalmology, Columbia University, and the Eye Institute of the Presbyterian Hospital. By a grant from the Harriman Glaucoma Fund.

0.5 to 0.25 mm. and left there for one-half to 1 second. The punctures included an area 2½ mm. distant from the corneal limbus and as far back as the insertion

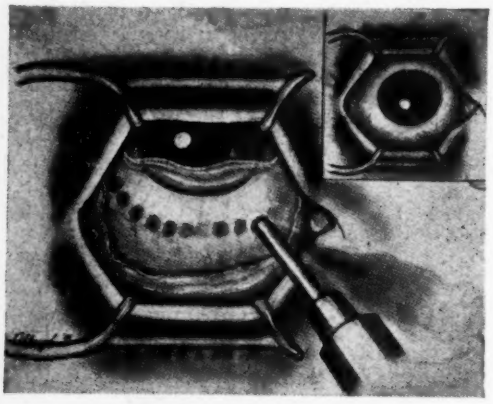

Fig. 2. Albaugh and Dunphy's method of nonperforating diathermy.

of the tendon of the inferior rectus, in front of the ora serrata. Laterally, they reached the insertions of the internal and external recti. The coagulated area thus included from one third to one half of the circumference of the globe.

Vogt stressed the fact that the punctures were made wholly in the orbiculus or pars plana of the ciliary body and that the ciliary processes were not touched. He stated that no theoretical explanation can be given for the action of his operation, but that the damage to the ciliary body (orbiculus in his case) may bring about a reduction of the secretion of the aqueous.

He used his method only in severe cases when all other methods had failed and in hemorrhagic glaucoma. The punctures produced an oozing of the vitreous body and the intraocular pressure was immediately lowered. He reported a case of necrosis of the sclera.

In 1939 Wagner and Richner,[5] following Vogt's methods, reported 47 operations of this kind for various types of glaucoma. They claimed that 72 percent were successful. Two cases were studied from the standpoint of pathologic findings.

At the meeting of the American Ophthalmological Society in 1943, Albaugh and Dunphy presented a paper on cyclodiathermy[6] in which they described two kinds of operation: first, perforating punctures applied according to the technique of Vogt but limited to only one quadrant of the circumference of the globe. They stated that the original Vogt method gave rise to great inflammatory reaction and had subsequent complications. By their second method a nonperforating diathermy, performed with a flat electrode of the Weve type, was applied 4 to 5 mm. behind the limbus in one row over one half of the globe (fig. 2). The electrode has to be applied hard against the sclera, otherwise there is no penetration of the current and the coagulation effect is only superficial. The authors preferred the latter method of diathermy and used it in 32 cases, with success in 25 and failures in 7 patients. They especially advocated nonperforating cyclodiathermy when other medical and surgical treatments had failed and when an opening of the globe had to be avoided because of the great danger of a sudden reduction of intraocular pressure.

At a meeting of the Chicago Ophthalmological Society in 1941, Dr. Samuel J. Meyer[7] gave a preliminary report of diathermy of the ciliary body. In the discussion that followed this communication, Dr. L. Bothman said that in the University of Chicago Clinic the operation had been performed not only on blind, painful, glaucomatous eyes for which other treatment had failed but also on one eye with 20/20 vision and on another with 20/100, with no further loss of vision in either. Although in most instances the tension

rose again in a few weeks, the patient was relieved of unendurable pain. Dr. G. H. Mundt stated that of three patients operated on, two had an excellent result as to tension. Ordinarily, operations can be performed under local anesthesia, but with this kind of procedure it is difficult. Although patients are given morphine and nembutal and fully prepared for surgery, they shrink from the diathermy.

Somewhat more recently, Dr. Dupont Guerry, III,[8] published an account of his experiments on the use of diathermy to block the long ciliary arteries and obstruct circulation of the ciliary body. He claimed to have obtained good results in producing permanent reduction of intraocular pressure in glaucomatous eyes.

Anatomic relations and distances of the structures of the angle in rabbit and man

The effect of diathermy varies not only according to the intensity of the current and the depth and length of application but also according to the anatomic place that is coagulated or destroyed. This last factor is of great importance, so that special consideration of the anatomic relationships of the structures in the angle of the anterior chamber is necessary before an operation is undertaken.

The relative distances from the orbiculus and processes to the iris root and angle of the anterior chamber in normal animal and human eyes were measured, freshly enucleated eyes being used which had been kept in formalin for one day. If a puncture is made with a Graefe knife into the sclera of a rabbit's eye, 2 mm. from the limbus on the nasal side, where the processes are longer, the tip of the knife will appear in the ora serrata exactly behind the ciliary body, not having touched the processes at all. When the puncture starts 1 mm. from the limbus, the knife divides the ciliary processes in half. When puncture is made exactly at the limbus and perpendicular to the scleral wall, the perforation cuts the head of the processes.

In the human eye a cataract knife puncturing the sclera 5 mm. from the limbus runs through the orbiculus but does not touch the processes. When the puncture starts 3 mm. from the limbus and perpendicular to the sclera, the blade perforates the ciliary body exactly behind the processes; when started 2 mm. from the limbus the knife reaches the anterior part of the processes at their base, just behind the iris; when introduced 1 or 1½ mm. behind the limbus, the perforation reaches the angle of the anterior chamber in front of the iris.

Using microscopic slides of normal human eyes one finds the distances of the structures at the upper part of the globe to be as follows: From the limbal edge of the conjunctiva to the bottom of the recess of the anterior chamber, 1 mm.; from the recess of the chamber to the posterior end of the processes, 1½ to 2 mm.; from the recess of the chamber to the ora serrata, from 4 to 5 mm. Sometimes this 5-mm. distance encroaches on the choroid. In view of these relationships it is evident that at 5 mm. and even at 3 mm. from the limbus, the distance at which cyclodiathermy is usually performed in man, only the orbicular region is seared. The processes are not touched, although there is, of course, some indirect effect on the organs, depending upon the intensity of the current and the extent of the coagulated area. It is necessary to make the diathermic puncture from 1½ to 2 mm. behind the limbus in order to reach the head and body of the ciliary processes. It should be remembered that in man the processes are comparatively short and the orbiculus covers a large area. Lagrange, who has made the same

measurements in human eyes, reported the following values: In the upper part of the globe from the edge of the limbus to the sinus of the chamber—1.75 mm.; at the lower part of the globe for the same distance—1.45 mm.; at the nasal side—1 mm.; at the temporal side—1 mm.

Physio-pathologic effects of destruction of the ciliary body

It is acknowledged that from a physiologic standpoint the orbiculus has probably no secretory function as regards the production of aqueous. The highly vascularized processes, on the contrary, are the source of this secretion and must be destroyed to a greater or less extent if a diminution of the fluid output and a lowering of the intraocular pressure are contemplated.

Wagenmann[9] (1890), experimenting on rabbits, found that section of the long posterior ciliary arteries produced a reduction in intraocular pressure by changing the vascular supply of the eye. Verhoeff[10] (1924) removed with a knife a part of the ciliary body to induce a lowering of the intraocular pressure, a method he called "cyclectomy." In support of his idea he mentioned the fact that injuries and inflammations of the ciliary body have a marked tendency to lower the pressure. He also considered that "cyclectomy" might alter the vascular condition in such a way as to reduce the intracapillary blood pressure.

H. Coppez[11] (1927 and 1929) reported his experimental work on diathermy in rabbits and concluded that the effect of this procedure is to destroy the ciliary body and thus diminish the amount of aqueous secreted into the anterior chamber. He stated that the results of the operation can be measured more or less by the amount of destruction to the ciliary body. When it is very limited, the tension returns to normal very soon; but if extensive, the destruction may produce not only a reduction of tension but at length an atrophy of the eyeball. He emphasized the importance of further studies in this direction.

The Weekers[12] made experiments in rabbits and think that the principal action of diathermy is an enormous vasodilation of the uveal vessels at the beginning of the ophthalmotonic reaction. This vasodilation is not limited to the point of application of the diathermy but extends over the whole iris and choroid. When the action of the diathermy is intense, hemorrhages, superficially and within the tissues, and exudations are common. When the limits of safety are passed, complications arise such as hyphema, iritis, cataract, choroiditis, and detachment of the retina. The healing process is slow and iris atrophy may be produced in the sector of the operation. When diathermy is extended to the whole circumference of the limbus, the atrophy of the iris may be so marked that the structure "disappears." Cataract and then atrophy of the globe end the inflammatory process. They believed that the vasodilation of the uvea is the cause of the hypotensive effect, but found this not to be permanent.

Meyer and Sternberg[12a] believe that the physiologic effect of Vogt's operation is only a "scleral shrinkage" with a consequent decrease in the total volume capacity of the eyeball. This lowers the intraocular pressure, but not always, to within normal limits and gives relief with freedom from pain. When an extensive diathermy is applied, including the complete circumference of the eye over the orbiculus ciliaris, hypertension may occur during the immediate postoperative period. If the tension rises above the systolic blood pressure in the central artery of the retina, the artery becomes occluded. This occurred in one of their cases.

Procedures

Experimental diathermy

The purpose of my experiments was: (1) to repeat the diathermy operations of previous authors and determine their effects on the membranes of the eye and the intraocular pressure; (2) to coagulate directly the ciliary-body base and processes and ascertain what amount of destruction to these organs was necessary to produce a long or even permanent lowering of the intraocular pressure; and (3) what effects the diathermic coagulation had upon the membranes and functions of the eye.

Ordinary diathermy machines were used, the large Lepel model and, in some animals, the Walker apparatus. At different periods of time after the operations the animal eyes were enucleated and hardened in formalin for two days. Then they were sectioned and submitted to the usual microscopic methods with serial sections made at the site of the operations. I soon found that this procedure was long and did not give a good perspective of the changes produced by the application of diathermy. A much easier and speedy method of observing the lesions produced was the microanatomic method with the slitlamp microscope which I have described elsewhere.[13] The eye was sectioned in front of the equator and its anterior half placed in a glass jar filled with a special solution. The specimen was pressed against the glass for observation, the cornea away from the glass. The segment was moved up and down and tilted back to illuminate the lesions and scleral scars. In this way a perfect stereoscopic view of the coagulation changes in the processes, orbiculus, and lens was obtained under varying magnifications (×15 and ×30). After this examination the most important specimens were submitted to serial sectioning and microscopic examination.

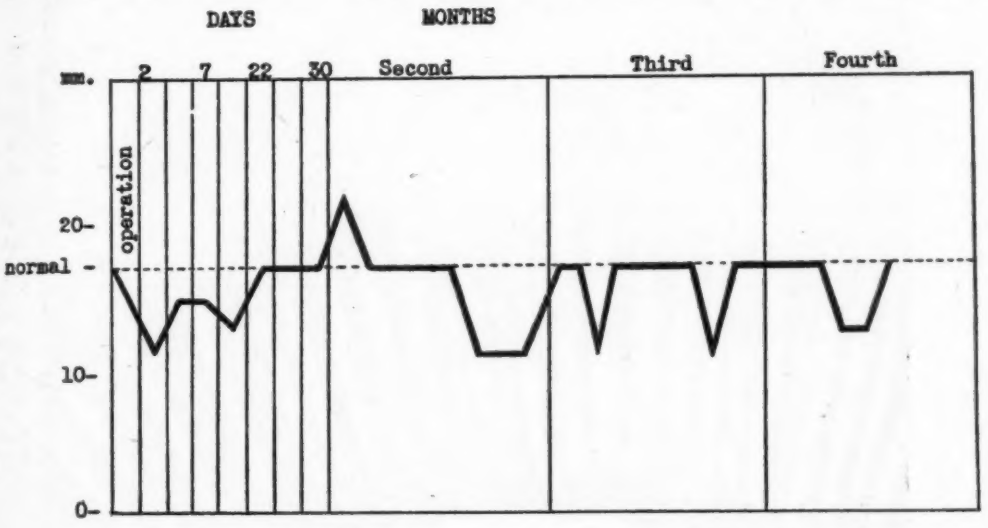

Fig. 3 (Troncoso). Tonometric curve in rabbit 7. O.D.

I. Vogt's transcleral method

Not being able to obtain Vogt's special needle, I operated with a thin electrode, and the perforations of the sclera were arranged in two parallel rows (instead of Vogt's 100) about 5 mm. distant from the edge of the cornea. In the rabbit the ciliary processes are longer than in man and the

orbiculus ciliaris is reduced to a narrow band so that Vogt's directions could not be followed implicitly. One row of perforations was made in the orbiculus but the second went farther back into the choroid.*

Rabbit 7, O.D. Pernostan anesthesia, retrobulbar injection of novocaine. The conjunctiva was divided 2 mm. from the limbus and a flap formed with two parallel meridional incisions. The episcleral tissue was removed and the sclera exposed. The indifferent electrode was wrapped in moist gauze and placed under the animal's belly. The perforations were made in two rows including about one quarter of the circumference of the eyeball. The flap was replaced and sutured. The next day the eye was inflamed and the conjunctiva swollen. There was some discharge. The iris and pupil were normal to slitlamp observation. Intraocular pressure was low (fig. 3). The reaction continued to be

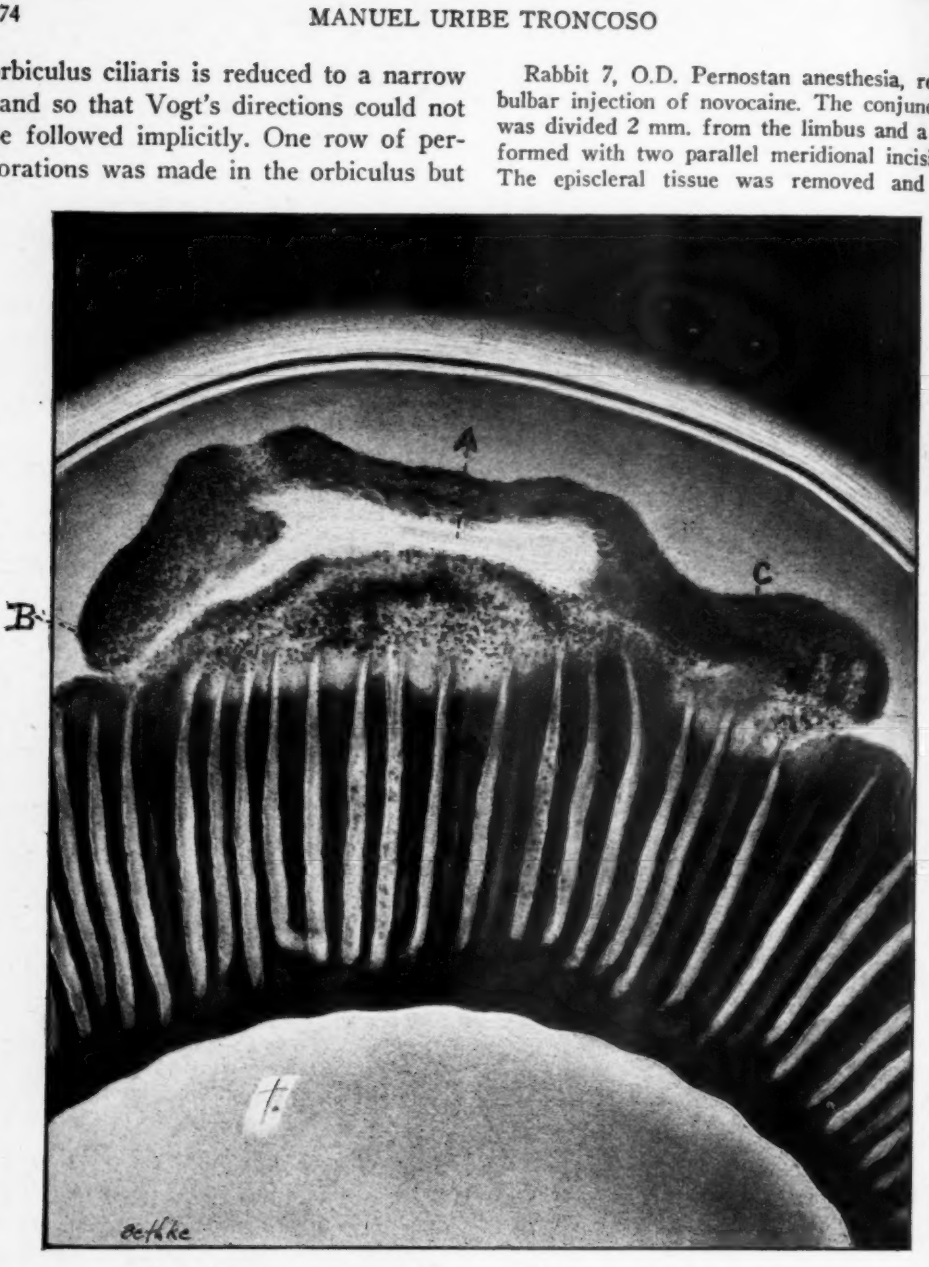

Fig. 4 (Troncoso). Experimental cyclodiathermy in rabbit 7, O.D.
Orbiculus ciliaris destroyed; scar tissue formed.

* The rabbit was used as the animal easier to handle, on which tonometric measures can be accurately made daily without the use of a general anesthetic. The presence of the membranous extensions of the processes has no bearing on the results of diathermy.

intense for four days and gradually diminished. The tension rose to normal after 18 days and then showed wide oscillations. At this time the reaction had subsided and the eye was quiet. The black holes of the perforations showed clearly through the conjunctiva. The animal was kept under observation for four months so that any further effects on the intraocular pressure might be observed.

Microanatomic examination. The enucleated eye was hardened in formalin and sectioned parallel to the equator. Examined under water with the slitlamp microscope (×15) the effects of the coagulation were clearly shown (fig. 4). The coagulation had affected the orbiculus ciliaris and part of the choroid. The punctures were fused together in a white, brilliant, branched band (A) surrounded above by a dark border of pigment grains (B) which extended beyond to the right to encircle a separated, round, coagulated scar (C). Under the white band, A, there was a semicircle of coagulated orbiculus and choroid which included the seared tips of some processes. The rest of these structures were superficially

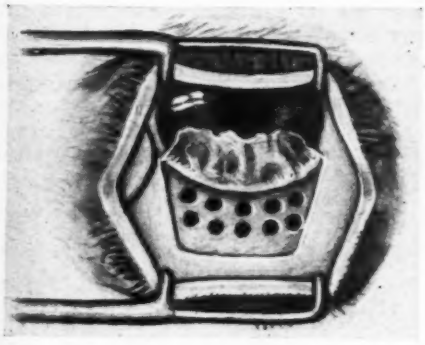

Fig. 5. Modified Vogt's method of coagulation of the orbiculus ciliaris in the rabbit.

coagulated but not destroyed. The processes under the hole (C) were also superficially seared. On each side of the changes and all around the limbus, the processes were normal. The equator of the lens appeared scalloped, but there were no marked opacities of the rest of the lens.

Microscopic examination. There was a proliferation and dispersion of pigment in the choroid and especially in the orbiculus, together with proliferation of the

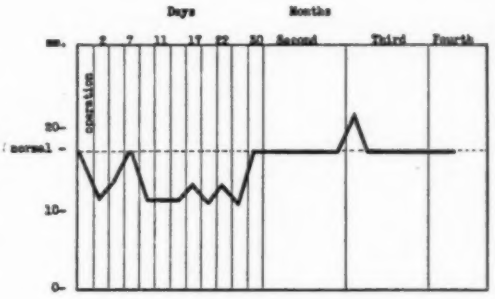

Fig. 6 (Troncoso). Tonometric curve in rabbit 8.

nonpigmented epithelium of the ciliary body. The blood vessels of the episclera were congested, and there was a leukocytic infiltration of the tissues; some of the leukocytes were laden with pigment. The sclera was somewhat thinned. The reaction extended from just behind the ora serrata to the periphery of the iris. The ciliary processes appeared normal.

In view of the slight action of diathermy on the ciliary processes by Vogt's method, other operations were made perforating the sclera immediately behind the limbus.

II. Vogt's method modified

Rabbit 8, O.S. Conjunctival flap as in the previous operation. Diathermic punctures were made in two rows of five punctures each (fig. 5). The scleral holes became black. The flap was replaced and sutured. The input current on the Lepel machine was 4 and the output 1½ degrees. The day after the operation, the reaction of the eye was much more active than after the previous operation, with great chemosis and discharge. The cornea was turbid and there was a slight iritis with exudate over the iris and contracted pupil. The tension came down to 11 mm. and then slowly rose to normal one week later (fig. 6). It fell again and stayed low with oscillations until the 25th day after the operation. The inflammatory reaction continued very

marked; the cornea was hazy and the pupil became oval under atropine. Cicatrization started slowly, and the inflammation subsided entirely about one month after the operation.

Microanatomic examination. The effects of the coagulation were very considerable. There was a brilliant white area of coagulation at the limbus, but the principal effect was apparent in the processes, which were completely destroyed, leaving only small white stumps near the ora serrata. The lesions were similar but not so intense as in figure 12. A peculiar fact was the preservation of the zonular fibers, which could be seen all over the coagulated area as fine, white, parallel threads extending from the ora serrata to the lens. The latter was swollen and seared at the spot in front of the lesions. The choroid showed a great dispersion of pigment.

Microscopic examination. The reaction extended from the periphery of the iris to the ora serrata. The iris was adherent to the posterior surface of the cornea, at this place blocking the angle. There was a marked proliferation of the pigmented and nonpigmented layer of the ciliary body just anterior to the ora serrata. The sclera over the treated area was reduced to about one half or three fourths of its normal thickness. There was an increase in the number of superficial blood vessels. Leukocytic infiltration and some hemorrhages were observed in the tissue. The ciliary processes were swollen and the apices destroyed.

III. Nonperforating diathermy

For comparison with the effect of Vogt's operation the nonperforating diathermy of Albaugh and Dunphy was used in several eyes.

Rabbit 13, O.D. A conjunctival flap was cut 7 mm. from the limbus, dissected, and rolled forward with the purpose of having a good protection for the seared spots. Diathermic coagulation was made with a spherical electrode, 1 mm. in diameter, in one row and about 5 mm. from the limbus (see figure 2). The electrode was pressed hard against the sclera until the membrane became blue-black but without perforating it. Six large spots were made. The input of the current was 3 divisions; the output 3¼. The next day the eye showed considerable reaction. The conjunctival flap was swollen, although the cornea was clear and the lens normal. The tension went down to 4 mm. and stayed low for 49 days (fig. 7). It then rose to normal but had another long downward oscillation. Ten days after the operation the

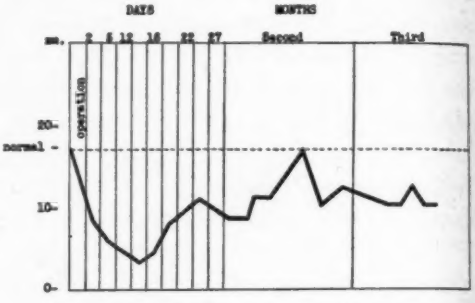

Fig. 7 (Troncoso). Tonometric curve in rabbit 13.

inflammatory reaction was still marked; the pupil was dilated, and the iris had numerous new vessels, observable under the slitlamp microscope. Below the lens capsule there were vertical, opaque streaks. Seventeen days later the eye became quiet; the cornea was clear but the limbus showed great vascularization. The animal was killed 2½ months after the operation.

Microanatomic examination. By transillumination the coagulated spots in the sclera appeared as thin, bluish, semitransparent circles. This rabbit was an albino, so the coagulation changes were not clearly recognized by differences in pigmentation and color. On the other hand, the greatly increased vascularization was readily observed in the normal processes whereas the coagulated ones were entirely deprived of vessels. Below the six seared scleral patches only two or three processes appeared white, semitransparent, and bloodless. The coagulation effects were mostly confined to the orbiculus and choroid. The choroidal

veins were greatly hyperemic and formed a beautiful, circular, branching design running parallel to the ora serrata. The lens was opaque at the equator, its contour becoming wavy.

IV. Nonperforating diathermy near the limbus

Rabbit 19. To study the effects of this operation directly over the ciliary processes, the coagulation spots were placed immediately behind the limbus. Six large searing circles were made with the ball electrode with a current input of 3 and an output of 3½. The searing effect depends not only on the intensity of the current, but upon the length of application and amount of pressure over the sclera. The reaction of the eye was very severe the next day, much greater than in previous animals. There was considerable chemosis, discharge, haziness of the cornea, and blood and exudates filled the anterior chamber. The pupil was dilated and the conjunctiva coagulated near the limbus. The inflammation continued to be intense for 15 days and then slowly subsided. The exudate in the anterior chamber became absorbed; the cornea cleared although it was covered above with new vessels. The iris became adherent to the lens upward, but was active. The lens was opaque at the site of the operation. Three weeks after the operation the eye became quiet. Hypotony was marked for 15 days and then the tension returned to normal after some oscillation. In another animal (rabbit 23) the inflammation was much more severe. At the end of two weeks the vascularized cornea began to dilate downwards and finally the ectasia invaded the whole cornea. The eye later became entirely soft and atrophic.

Microanatomic examination. The large coagulated spots on the sclera appeared as brown areas extending beyond the ora serrata. At other places the choroid and retina were fused together and coagulated. Exudates in the shape of membranes or threads extended in places from the ciliary body to the lens. The processes were entirely destroyed for about one third of the circumference of the eyeball. Their original places were filled with brown masses of tissue on which white striae ran parallel. At some spots the coagulated processes had kept their shape. The corneal opacity was due not only to a direct searing, but also to the obliteration of the perilimbal vessels which considerably disturbed the nutrition of the corneal membrane. The lens was swollen and opaque upward. The eye later became entirely atrophic and soft.

Comments. Perforating diathermy by the method of Vogt from 2½ to 5 mm. from the limbus produced large coagulated areas in the orbiculus ciliaris and choroid but had but a slight, only indirect effect on the processes. The fact that even in the rabbit, which has such long processes and narrow orbiculus, the former were not directly affected indicates that in man, whose orbiculus is so wide and whose processes are small, the Vogt diathermy would be effective especially in the orbiculus. This method produces a severe inflammatory reaction which ends in a cicatricial atrophy of the membranes. The lowering of the tension is only transitory.

When the diathermic punctures were made in the rabbit 1½ mm. from the limbus, the processes were completely destroyed at the site of coagulation. The inflammatory reaction was, however, much more severe. There was an involvement of the iris and lens. The lowering of the ocular tension was only temporary. It is surprising that even after this severe traumatism the eye recovered and did not show externally the great destruction of the inner structures. Probably through a compensatory mechanism, the overaction of the remaining processes raised the tension again to normal.

The nonperforating diathermy of Albaugh and Dunphy, placed 5 mm. behind the limbus, produced not only a coagulation of the orbiculus but also had an effect on the processes, which appeared avascular and seared. Probably on this account, lowering of the ocular tension

was more marked than after the use of the ordinary Vogt method. The reaction had a shorter duration.

Inflammation of the iris and changes in the lens make both of the original methods, perforating and nonperforating, applicable only to old glaucomatous eyes, as a last resort for alleviating pain and lowering the tension. The nonperforating diathermy appears to be the more effective and the less dangerous.

New methods of surgical diathermy of the ciliary body

In the operations previously described the effect of the diathermy was always spread over a large portion of the orbiculus, ciliary body, and choroid. In the operations that follow, my idea was to limit the diathermic coagulation to a few, three to six, processes and to study the effects that this diminution of the secretory power of the ciliary body may have upon the nutrition of the eye and the balance of the intraocular fluid. Two methods of approach were tried: (1) the posterior route, by incising the sclera 5 mm. from the limbus, as in a cyclodialysis operation, and coagulating the ciliary body through the incision; (2) the anterior route, by sectioning the cornea, performing an iridectomy, and then attacking the ciliary body from in front.

A. Direct, localized diathermy of the ciliary body—scleral route. Rabbit 6. O.D. After a conjunctival flap was made, a scleral incision 5 mm. from and parallel to the limbus was made, as for a cyclodialysis operation. When the ciliary body was exposed, a spatula was introduced, hugging the inner side of the sclera, and was pushed into the anterior chamber. It was slowly withdrawn without making any lateral movements. In its place a fine diathermy wire was introduced into the anterior chamber and the coagulation current turned on for 10 seconds until the tissue underneath the wire was seared. After the electrode was withdrawn, a small vitreous bead prolapsed but did not rupture. The conjunctival flap was replaced and sutured. The current input on the Lepel machine was 3 and the output 3½. Two days after the operation there was a slight reaction, with swelling of the flap and discharge. The slitlamp examination showed the cornea to be clear and a small white-red exudate covering the iris at the site of coagulation under the limbus. Seven days later the eye was only slightly inflamed, but an accidental trauma broke the conjunctival suture and allowed a small vitreous hernia to appear. The flap was again sutured into place. On the iris a radial, dark, linear depression showed, due to the coagulation. Two weeks after the operation a slight iritis was present with aqueous flares, deposits of pigment in the lens, and a small posterior synechia. Under the action of atropine the pupil dilated, except upward, and the lens proved to be clear. With the ophthalmoscope a small hemorrhage could be seen in the anterior part of the vitreous. One month after the operation the eye was normal. The hemorrhage had become absorbed and the iris showed a white atrophic spot at the site of the operation. The intraocular pressure was reduced and stayed low for 19 days then rose and remained normal with oscillations for one month.

Microanatomic examination. The scleral scar from the inside (fig. 8) appeared as a round, white, depressed tissue (A) half of which was located beyond the ora serrata and half in the ciliary body, with clear-cut pigmented margins. Pigment was also massed in the choroid (B). About five processes had been entirely destroyed in the area of the corona. They were drawn together in the middle by a mass of cicatricial tissue, made of strong, white strands. On either side of the coagulation the processes were normal. The lens was clear.

Microscopic examination. A localized area of the sclera over the ora serrata was thinned to about one half of its normal thickness. In this area there were leukocytes, red blood cells, and a dispersion of pigment. The adjacent pigmented and nonpigmented epithelium of the ciliary body had proliferated. Near this site were chorioretinal adhesions. The base of the processes was swollen but there was no peripheral synechia.

B. EXTENSIVE DIRECT DIATHERMY OF THE CILIARY BODY. Rabbit 4, O.S. Conjunctival flap as in previous operations. The scleral incision was made 2 mm. from the limbus with the object of reaching the processes more directly. The spatula was moved laterally, detaching the ciliary body for about one fourth of the circumference, as in ordinary cyclodialysis. The diathermy wire was placed over the ciliary body and moved from side to side, the current being increased gradually until the iris (seen from the front) became seared and changed in color (fig. 9). There was no loss of vitreous. The current input for this operation was 3 and the output 3½. The conjunctival flap was sutured. Two days later the eye showed little reaction. The conjunctival flap was swollen and there was some discharge. The cornea was clear and there was a slight hemorrhage over the iris below the site of operation. Five days later the reaction had subsided; the pupil was contracted. With the slitlamp the iris showed numerous new vessels and a black streak below the wound. The pupil was normal; there was no synechia. The conjunctiva was still swollen.

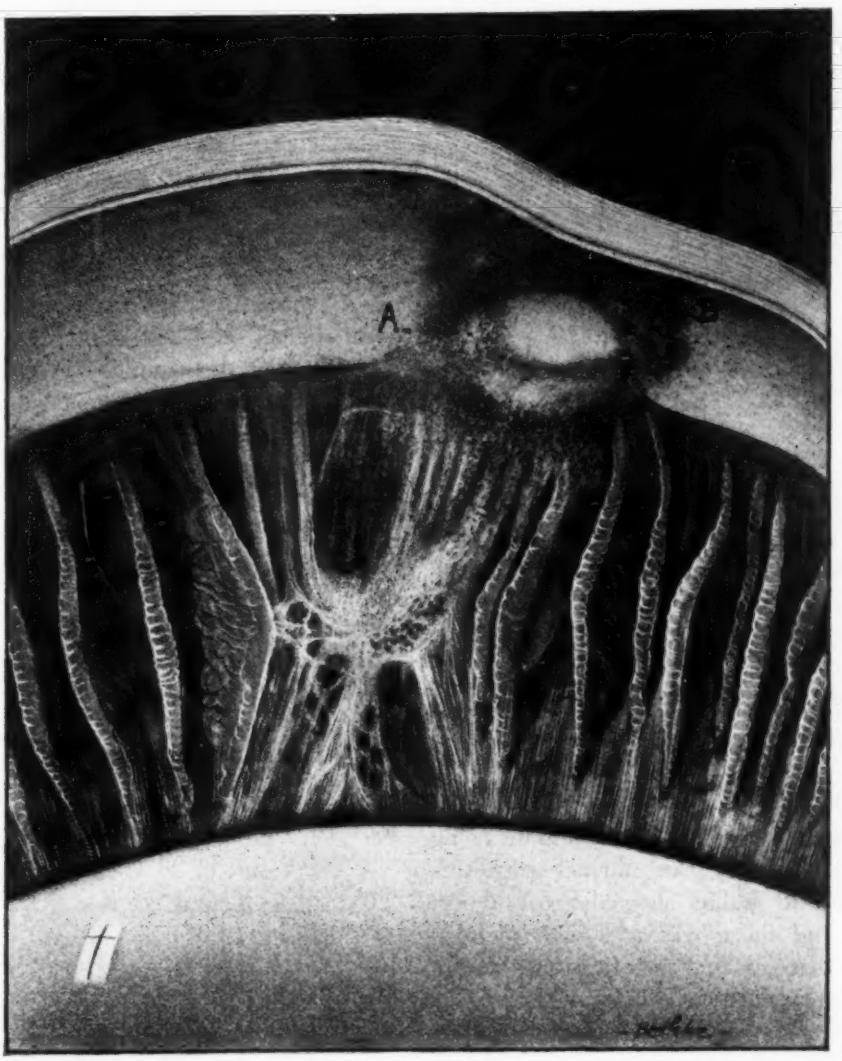

Fig. 8 (Troncoso). Experimental cyclodiathermy in rabbit 6, O.D. Ciliary process destroyed; scar tissue formed.

The intraocular pressure was very low, 9 mm., and remained so for 17 days, after which it rose to normal (17 mm.) with downward oscillations (fig. 10). Twelve days after the operation the coagulated area in the iris took on a white color; the pupil became oval. The scleral edge of the wound, which probably was coagulated, had contracted. Later the scar took a bluish color and was translucent by transmitted light. Three weeks after the operation the eye was entirely normal.

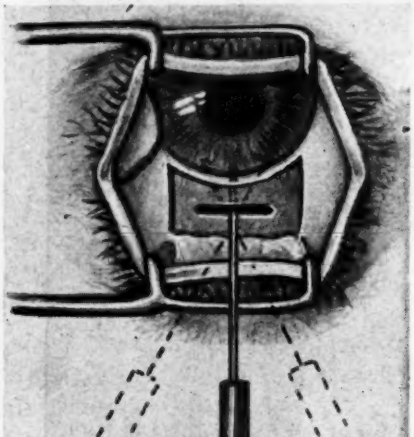

Fig 9 (Troncoso). Direct diathermy of the ciliary body—posterior route. Incision in the sclera as for cyclodialysis. The electric wire was moved from side to side to coagulate the ciliary body extensively.

Microanatomic examination. This being a white rabbit, the normal processes around the limbus showed great hyperemia, and there was a wreath of congested veins around the ora serrata except at the place of coagulation. The scleral scar, larger than in the previous rabbit, was elliptical, semitransparent, and depressed. Below it, a number of processes (about 6 or 8) had been entirely destroyed, only parallel lines of striae remaining visible over a white, seared background.

Microscopic examination. Over the site of the treated area the sclera was reduced to one half its normal thickness. The fibrous tissue composing it had changed its staining reaction from green to red, owing to newly formed fibroblastic tissue. Descemet's membrane was ruptured. The overlying processes apparently had become necrotic. They had lost their epithelial elements except along the inner surface where new epithelium had grown over. A network of fibroblastic stroma and newly formed fibroblasts was growing into the necrotic stroma.

C. Direct bipolar diathermy of the ciliary body. With the purpose of localizing the effect of coagulation between two parallel electrodes and avoiding the passage of current through the indifferent electrode, the bipolar method of coagulation was tried in several animals. Since the two wires or prongs can be moved laterally to increase or decrease the distance between them, the extent of intended coagulation in the tissues can be exactly measured. It should be stressed that the effect of this type of diathermy is considerably stronger than when the ordinary method of coagulation is used.

Rabbit 7, O.S. After the conjunctival flap had been rolled back, a scleral incision was made about 1½ mm. from and parallel to the limbus. The prongs with a 3-mm. separation were pushed directly forward upon the base

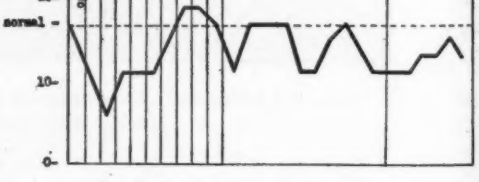

Fig. 10 (Troncoso). Tonometric curve of rabbit 4.

of the ciliary body but did not penetrate easily. A spatula was therefore introduced and the ciliary body detached from the sclera for

about 5 mm. The two wires were then introduced as far as the anterior chamber and the current passed for 20 seconds (input 2 and output 1½). Immediately the cornea became hazy and the iris took on a black coloration at the site of coagulation. The flap was then sutured to cover the incision. Two days later, the inflammatory reaction was moderate. The conjunctiva was swollen, the cornea hazy above, and there was a dispersion of pigment in the pupillary area. No hemorrhages were visible. In six days the reaction had subsided. The tension rose considerably after the operation, then became very low, and returned to normal with large oscillations (fig. 11). Surprisingly, the eye recovered quickly after the operation so that on the tenth day it appeared almost normal. The cornea was clear and the pupil active. The animal was killed three months later. In only one of the four rabbits submitted to this method did exudates appear in the anterior chamber and hemorrhage over the iris.

Microanatomic examination. In contrast to the slight inflammatory reaction, the destruction to the ciliary body was enormous (fig. 12). Over the ora serrata were two white scars connected below by a bridge of fibrous tissue, a prolongation of which came down toward the lens. The scar was surrounded by an area of pigment dots in the choroid. The processes were entirely destroyed, shortened in the center, distorted, and coagulated on either side. At the left, strands of fibrous tissue bound the scar to the processes. The lens was swollen and coagulated above. The zonular fibers were probably coagulated but kept their normal arrangement and insertions.

COMMENTS ON THE DIATHERMY METHODS BY THE POSTERIOR ROUTE. The operations previously described establish the fact that direct diathermy of the ciliary-body base and processes is capable of destroying a number of processes without producing intense inflammatory reaction within the eye. The coagulation of a few processes can be obtained with little local effect and without greatly disturbing the nutrition of the eye. In fact it is surprising to observe how slight the general reaction is and how quickly it subsides. The intraocular pressure in the beginning remains very low, a factor commonly noted in many other operations whereby the sclera is perforated. However, after some time (21 days in rabbit 4), it almost always returns to normal. This latter eventuality is most likely due to a compensatory mechanism that brings about a hyperemia of the remaining processes and restores the secretion to a normal level. Thus the assumption that a limited destruction of the processes could produce a long, or perhaps a permanent, lowering of the intraocular pressure was not confirmed by the facts. This of course applies only to normal eyes. In congested, glaucomatous eyes, whose processes are usually involved, congested, and edematous, it is probable that the compensatory mechanism referred to will not work so effectively. In simple glaucoma where there are no congestive symptoms, conditions approach those in normal eyes.

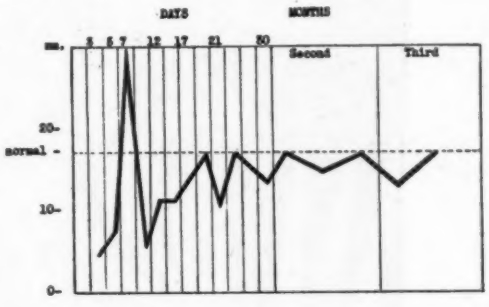

Fig. 11 (Troncoso). Tonometric curve of rabbit 7, O.S.

Bipolar diathermy was undertaken with the idea of localizing the effect of coagulation to a certain area of the corona ciliaris more effectively than with the ordinary method of indifferent electrode. The experiments proved, however, that the results of the coagulation were enormous, and although the inflammatory reaction was not very marked the bipolar

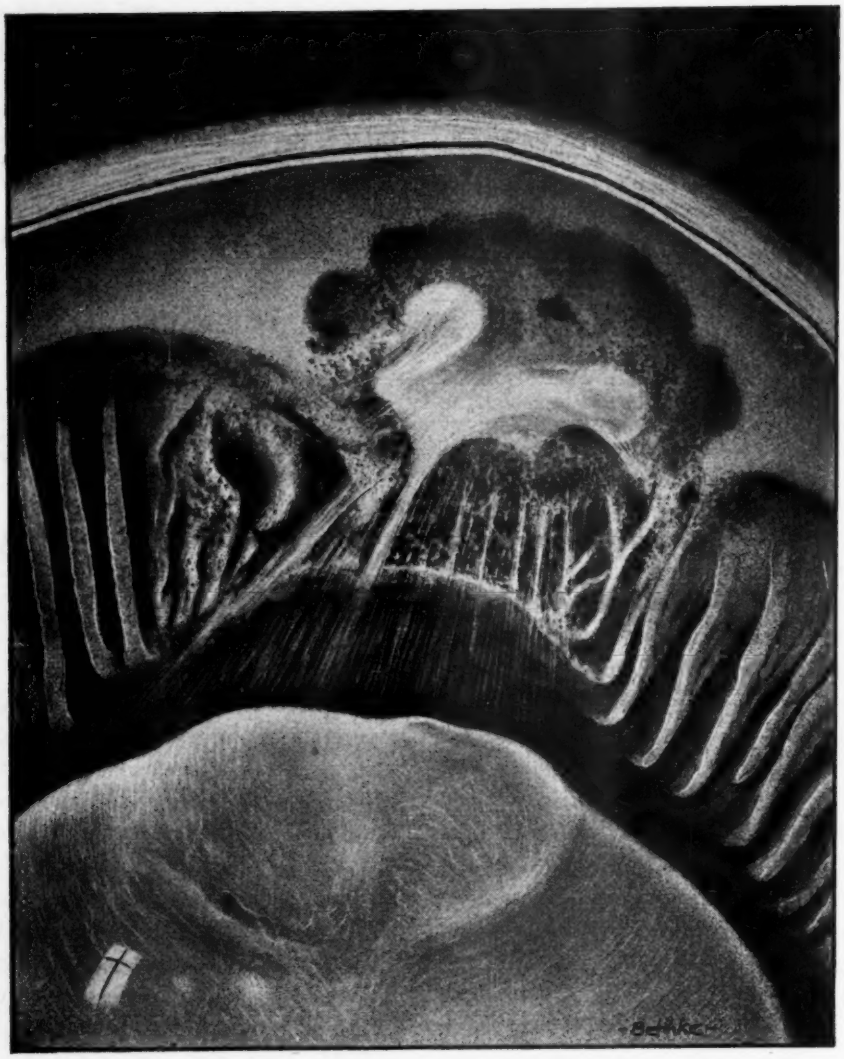

Fig. 12 (Troncoso). Experimental cyclodiathermy in rabbit 7, O.S. Bipolar method. Ciliary process destroyed; scar tissue formed.

method offered no great advantage over the ordinary form of coagulation.

D. DIATHERMIC SURGERY OF THE CILIARY BODY—ANTERIOR ROUTE. In surgery of the ciliary body, unfortunately, the electric knife cannot be used for excision of a part of the organ as in surgery of the brain. Too many important neighboring structures such as the zonula, lens, and others, would be irreparably damaged. Coagulation by diathermy of a portion that stays in place would not induce so severe a trauma. With this in mind, I undertook the experimental destruction of a part of the corona ciliaris from in front through a wide iridectomy.

Rabbit 19, O.D. A corneal incision was made with a Graefe knife behind the limbus and including about one fourth the circumference of the globe. The iris was grasped with forceps, pulled out, and a broad iridectomy performed. The corneal flap was seized with a straight

forceps and rolled over until the ciliary body was well exposed. In the rabbit, iridectomy detaches the iris root and pectinate fibers from the scleral wall and leaves exposed the iridic portion of the ciliary body which includes the processes. In man, iridectomy exposes the ciliary-body front with the ciliary processes extending downward to the zonular fibers. It is easier to attack the ciliary-body base than the individual processes. A fine diathermic wire was introduced into the ciliary-body base in a meridional direction, about 1 mm. below the inner surface of the sclera, and pushed back for 2 or 3 mm. inside the black structure (fig. 13). Diathermy is more effective if the tissues are dried before the wire is inserted. The coagulation current was then applied. It was necessary to make 5 or 6 punctures to cover the area in two

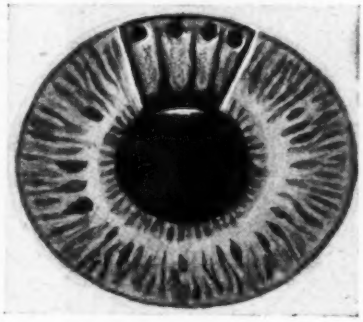

Fig. 13 (Troncoso). Direct diathermic surgery of the ciliary body—anterior route. The electric wire penetrated the base of the processes immediately below the limbus to a depth of 2 to 3 mm.

rows. The current input was 2, output 4. A slight amount of vitreous was lost. In this rabbit the structures had a tendency to prolapse through the wound; the conjunctival flap was therefore securely tied over the incision.

The course of the operation was favorable. Two days later the reaction of the eye was scant. The cornea was slightly hazy over the coloboma. Atropine, 1 percent, and sulfathiazole salve were applied. Fifteen days later the eye was quiet. Under slitlamp examination the wound was found not to have closed entirely at the center, a shred of tissue remaining between the lips. The cornea was hazy and showed many new vessels above. The coloboma was normal. Some of the pigment was deposited over the lens, which had a transparent vertical streak under the capsule. The fundus seemed normal. The slight ciliary hernia was touched twice with trichloracetic acid, and one month later the eye appeared normal, except for a slightly protruding corneal scar. There was some stippling of the cornea above, and two small posterior synechiae at the base of the coloboma. The lens was clear and the fundus normal to ophthalmoscopic observation. The tension went down after the operation (8 mm.), stayed low for 15 days, and then came back to normal, with up-

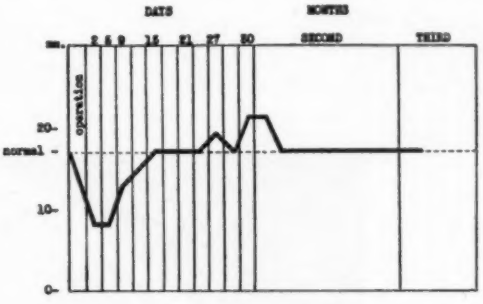

Fig. 14 (Troncoso). Tonometric curve of rabbit 19.

ward oscillations (fig. 14). The eye was enucleated two months after operation.

Microanatomic examination. At the site of the coagulation there was a brilliant, fluffy-white spot where the processes were entirely destroyed (fig. 15). Above it lay a seared brown area. A peculiar condition was the curving of the processes, which were drawn toward the scar and blended with it on either side. This adhesion probably involved first the membranous extensions of the processes, peculiar to rabbits' eyes. The ora serrata at the place of operation was irregular and wavy. The lens had a notch at the equator in front of the coagulated area but remained transparent at the center. All other structures around the coagulated area were normal.

Rabbit 20. The same technique was used except that the current was increased to input 3 and output 2 to 3, and a corneal suture was applied. The inflammatory reaction was slight, and the eye returned to normal one week later. From the corneal scar many short, new vessels ran downward. The coloboma was normal and the lens clear. There was no synechia.

The *microanatomic examination* of this eye showed a picture similar to that in the

preceding animal, but the coagulation included the whole length of the folds to the ora serrata. The processes at their bases had the same peculiar curvature and were drawn together to form an arch over the equator of the lens. The latter did not appear involved.

COMMENTS. These experiments show that it is possible to destroy a given area of the ciliary body when pathologic changes are present in the processes, with no great inflammatory reaction or danger to the eye. However the principal purpose of the experimental work reported previously was primarily to determine if a localized destruction of the ciliary processes in a small or large area could by itself produce a permanent hypotony of the eye and to apply these findings to the treatment of glaucomatous eyes. The localized destruction of the ciliary body in these experiments was disappointing because, although it induced an immediate reduction of tension, a permanent hypotony was not obtained. Confirming Coppez's views, I may conclude that when the destruction of the processes is limited to a small number, the intraocular pressure returns to normal after a shorter or longer period of time. When the destruction is extensive, the great inflammatory reaction and considerable trauma endanger the integrity and functions of the eye and usually fail to produce a permanent hypotony.

Fig. 15 (Troncoso). Surgery of the ciliary body of rabbit 19, O.D.

E. TRANSLIMBAL DIATHERMY. In view of these results I attempted to combine in

a different operation the advantages of a localized destruction of the processes and the effects of a fistulizing operation through the sclera. The destruction of a few processes does not induce a considerable reaction, and when the scleral wound is healed the cicatrix is soft and probably permeable to the intraocular fluids. The fistula or at least a filtering scar in a thinned sclera can be obtained by making a diathermic puncture in an oblique direction through the limbus until the tip of the wire appears in the anterior chamber. The following experiments show the results of this new approach.

Rabbit 12, O.S. Pernostan anesthesia was used and retrobulbar novocaine injection. An incision 6 mm. long was made in the conjunctiva parallel and about 1½ mm. distal to the limbus. On either side of it a meridional incision was cut out and the flap dissected and rolled back. (It is better to roll it back in order to obtain an unobstructed view of the limbus and anterior chamber.) A diathermy wire of medium thickness was connected to the machine and the panel set for coagulation of tissues. After being wrapped in wet gauze the inert electrode was placed under the belly of the animal. The operator uses a switch pedal or, better, a holder with a finger lever for interruption. The current intensity of the Lepel machine was input 2 and output 3 to 4. With the current on, the wire was pressed firmly against the sclera, 2 mm. from the limbus, and pushed gradually in an oblique direction until the tip appeared in the anterior chamber. (Slight lateral movements can be made to increase the size of the puncture.) The angle of perforation should be about 30 to 45 degrees (fig. 16). The time the needle stays in place is very important, for the longer it remains the larger the perforation. The sclera becomes blue-black at the edges of the hole; the iris changes to a darker hue, and usually a line of coagulation appears over its surface. Although the wire may be rapidly withdrawn, the aqueous frequently flows out through the perforation. The conjunctival flap is then replaced and sutured to the limbus. If the aqueous is not lost, a second oblique perforation can be made, if desired, 5 or 6 mm. away from the first.

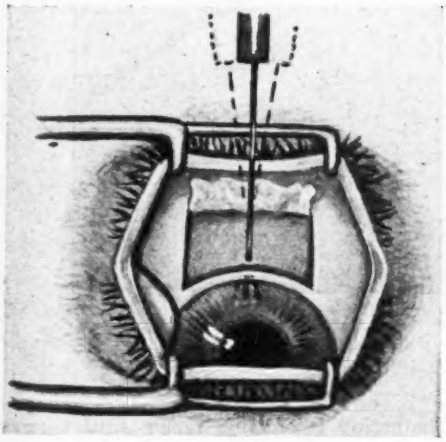

Fig. 16. (Troncoso). Translimbal diathermy to produce a limbal fistula. The electric wire penetrates directly into the scleral limbus in an oblique direction and then into the anterior chamber. It is kept there until the scleral holes become blue-black.

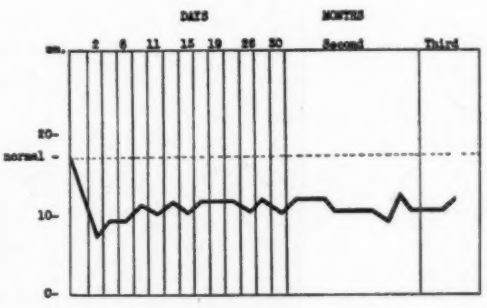

Fig. 17 (Troncoso). Tonometric curve of rabbit 12.

In the following days the reaction was slight. The flap was red and a little swollen. Since the rabbit was an albino, the coagulated spot in the iris appeared dark, with a thin brown-red line where its surface was seared. The cornea was clear and the pupil normal. The tension was low (7 mm.), Atropine was instilled. Ten days later the eye was almost normal. Viewed through the slitlamp the cornea showed small punctate opacities in the vicinity of the wound. The iris was covered with new radial vessels, and a slight exudate bound it to the lens at the coagulated spot. One month later the cornea still had punctate exudates; there were some new vessels along its surface. The pupil was free. The conjunctiva encroached slightly upon the cornea at the fistula and was edematous. The intraocular pressure showed a remarkably low curve (fig. 17). From 7 mm. of mercury after the operation it rose to 11 mm. and remained there with small oscillations for over two months, when the rabbit died suddenly from an intercurrent disease.

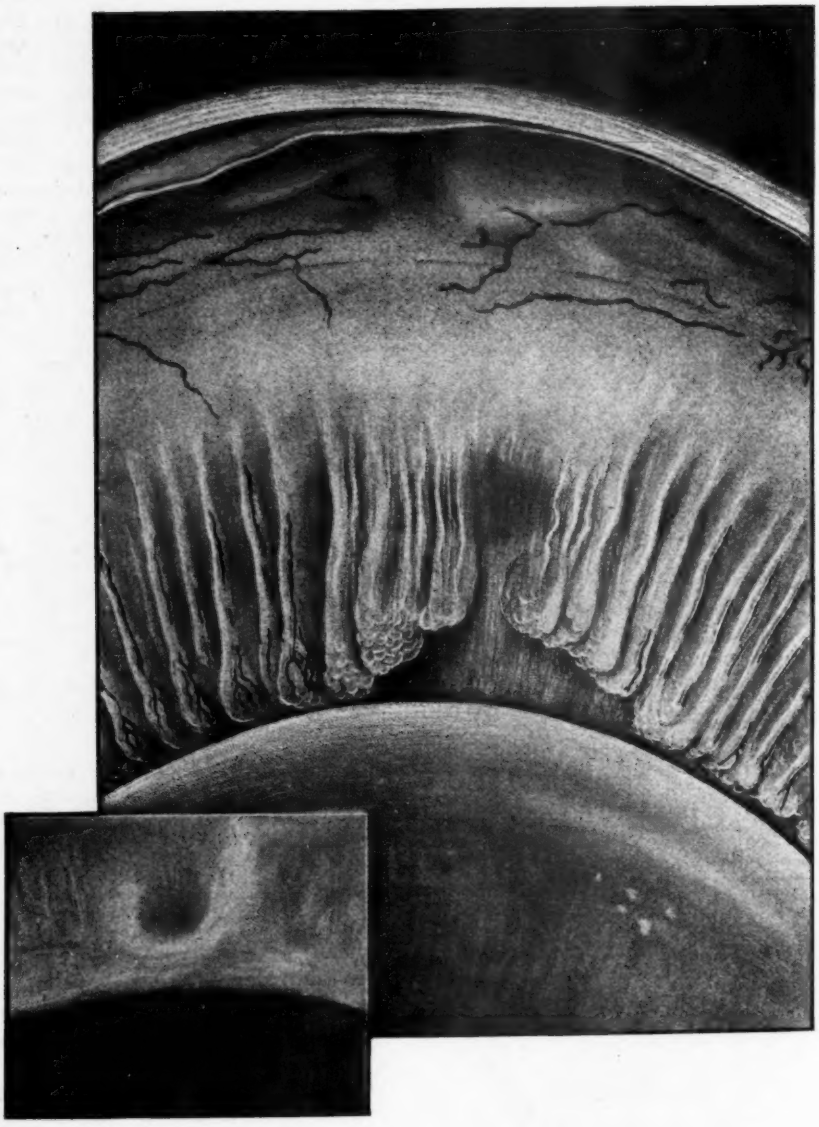

Fig. 18 (Troncoso). Experimental translimbal diathermy in a white rabbit. Ciliary process destroyed. At the bottom of the gap the perforation of the sclera appears as a thinned round area.

Microanatomic examination. At the site of the operation two processes were entirely destroyed, leaving an empty space in the corona ciliaris (fig. 18). At the bottom of this space the electric puncture appeared as a small round darker area. Three processes on either side of the gap were coagulated, thinned, shortened, and entirely deprived of vessels. The zonular fibers could be seen running normally over and at the side of the coagulated processes. All around the limbus the remaining processes were intensely hyperemic. The choroidal vessels were also

congested and ran in branched twigs parallel to and all around the ora serrata. The lens was clear throughout. Examined from in front, the specimen showed the puncture as a round, dark depression under the conjunctiva 2 mm. from the limbus. The scar appeared to be closed by new tissue formation. By indirect illumination it looked thin and translucent.

In several rabbits operated on by the same technique, hypotony was always marked, with small oscillations, until the animal was killed.

Translimbal punctures made in man will probably coagulate also the trabeculum and Schlemm's canal if the angle is open at this point. However, it should be remembered that peripheral synechias are quite frequent after other operations; namely, on either side of a trephine opening.

Modifications of the translimbal operation

A. Surgical knife. The surgical knife was tried side by side with the coagulation wire in rabbit 15. The knife penetrated more easily and rapidly through the sclera than did the coagulation wire. On the following day the iris showed a white triangle of seared tissue at the surgical penetration, whereas at the site of the coagulation the iris was seared in a larger area. The results of the operation were good and the tension remained low but went back to normal 20 days later. The animal was then killed.

The *microanatomic examination* proved that at the place of perforation with the surgical knife very slight changes had been produced in the processes, whereas at the site of coagulation five processes had been considerably seared. It is necessary to point out that when the intensity of the coagulation is low and the time of application short, the holes heal rapidly and very little or no effect is produced in the processes (rabbits 15 and 17).

B. Thicker wire. A wire about the size of an ordinary pin with a sharp point was tried but the penetration power was small. In rabbit 20, the effects were marked. A large number of processes were destroyed (about eight) and the choroid was seared. However, even with this great traumatism the inflammatory reaction was not considerable. In another rabbit, a fibrinous exudate, pink in color, covered the lower half of the pupil. The cornea was slightly turbid and the anterior chamber shallow. Four days later the exudate was absorbed, and the eye became quiet. The lens remained clear. Hypotony was considerable for the whole period with some oscillations.

C. Transcleral perforation. A perpendicular perforation was tried on rabbit 21 simultaneously with an ordinary oblique translimbal puncture. The wire was first introduced perpendicular to the sclera, 1½ mm. from the limbus and about 2 mm. in depth. It was kept in place until the sclera turned blue-black. Then a few millimeters away a regular translimbal operation was performed. The idea was to reinforce the effect of the latter and to obtain a greater destruction of the ciliary body. After the operation the reaction was slight; the tension was very low. The cornea was clear and the lens transparent.

Twelve days later the eye was enucleated and the *anatomic examination* showed very great destruction. Around the transcleral puncture the processes and choroid were coagulated in a large area and a hemorrhage was present partly over the processes and partly over the equator of the lens. The translimbal puncture at one side had destroyed only four processes and the coagulation was limited.

In another rabbit (rabbit 22, O.S.)

wherein the transcleral perforation was not so large and deep, the coagulation effects were not so marked and no hemorrhages occurred. To be positive that no hemorrhages or excessive destruction had been produced with the ordinary translimbal method, rabbit 22 was killed two days after the operation. The anatomic examination showed that four processes were coagulated, but no hemorrhage nor exudates were apparent.

COMMENTS ON TRANSLIMBAL DIATHERMY. A fistulizing operation combined with the coagulation of a small number of processes had the immediate effect of lowering the intraocular pressure. Experimentally, hypotony has been induced for as long as two months. It has proved to be a safe procedure which does not produce a great inflammatory reaction and can be repeated several times in different sections of the limbus. Usually, however, the scleral puncture closes, leaving a thin, depressed cicatrix. Ordinarily, no iridectomy was performed, so that the intact iris membrane could protect the lens from the effects of heat. However, there is no objection to an iridectomy followed by the translimbal puncture, if the latter is made quickly to avoid great heat near the lens.

In congested, glaucomatous human eyes the severe hyperemic effect of diathermy on the ciliary body and choroid may probably be added to the advantages of the fistulization. As Weekers and other authors have pointed out, it is likely that the active hyperemia produced by diathermy changes the circulatory conditions inside the eye and relieves the congestion and stasis of the inner membranes.

CLINICAL APPLICATIONS. Four translimbal operations have been made in patients suffering from old, congestive-type glaucomas. They have been successful in lowering the intraocular pressure and bringing it to normal, but, unfortunately, the results have not been permanent and a second or third operation had to be performed. A good lasting effect was obtained, however, in a case of secondary glaucoma following a cataract operation. In general it can be stated that the use of diathermy for lowering intraocular pressure has not fulfilled the expectations that many authors, including myself, have entertained about the considerable advantages of this therapeutic method.

SUMMARY

By experiments on rabbit eyes it has been attempted to determine the physiologic bases of diathermic methods, their action on the intraocular pressure, and the damage done to the ocular structures. Vogt's method of multiple perforations of the sclera in the region of the orbiculus ciliaris had no physiologic basis, for the orbiculus has no part in the secretion of aqueous. The method produced a severe inflammation which ended in atrophy of the orbiculus, and had but little effect on the processes.

Albaugh and Dunphy's method of a nonperforating diathermy also acted especially on the orbiculus, although it did have an indirect effect on the processes. It also induced a severe inflammation which ended in atrophy.

When multiple perforations were made experimentally behind the limbus to reach the processes, the results were severe and these organs were destroyed. If the area of coagulation was extensive, intense reactions with exudates, hemorrhages, and lens changes appeared. In some cases the eye became atrophic.

The author tried to determine by direct local coagulation of a small number of processes whether their destruction could produce a prolonged hypotony. He used two routes of approach: the posterior through the sclera and the anterior through the cornea. By the former

method, after making a scleral incision as in cyclodialysis, he introduced a spatula into the anterior chamber then the diathermy electrode, coagulating the ciliary body base either with a single puncture or by moving the wire laterally. The eyes tolerated the coagulation well, and there was little inflammatory reaction. The intraocular pressure remained low for three weeks but then rose to normal. When the coagulation was more extensive, the reaction was greater, although the eye recovered completely three weeks later. The tension was very low and remained so for 17 days, after which it returned to normal. Slitlamp examination of the enucleated eyes clearly showed the extent of destruction in the processes.

Diathermic coagulations via the anterior approach were made after a corneal incision and a broad iridectomy had uncovered the ciliary body and processes. The electrode was pushed directly into the ciliary-body base above the processes. Four to five coagulations were made. The inflammatory reaction was not severe; the cornea was slightly opaque near the wound, a posterior synechia developed, and the lens showed a linear opacity. The tension stayed low for 15 days and then returned to normal.

As these methods did not produce a lasting lowering of the intraocular pressure, the author tried to combine the limited destruction of the processes with a fistulizing operation. He called this method a "translimbal diathermy." After making a conjunctival flap, he introduced the diathermic wire boldly through the sclera, 2 mm. behind the limbus and pushed obliquely through the ciliary body until the tip appeared in the anterior chamber. The wire was left in place for a few seconds until the perforation was about 2 mm. wide. The flap was then sutured. In several rabbits he was able to obtain considerable hypotony. The scleral aperture remained open for two to three months but later closed. In some animals a filtering scar was obtained. However, the author considers the results of diathermy disappointing from the standpoint of a permanent lowering of the intraocular pressure.

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A CASE OF ATYPICAL ACHROMATOPSIA*

LOUISE L. SLOAN,† PH.D.
Randolph Field, Texas

INTRODUCTION

Typical achromatopsia is characterized by complete absence of chromatic color perception in association with other symptoms attributable to absence or loss of function of the retinal cones. The associated findings are as follows:

(1) Visual acuity is reduced, usually to about 20/200. Other evidences of foveal impairment found frequently but not invariably are nystagmus and a central scotoma.

(2) There is a shortening of the long-wave-length end of the spectrum and a shift in the region of maximum brightness toward the short-wave end.

(3) Exposure of the eyes to light of fairly high intensity produces rapid blinking or partial closure of the lids. This photophobia, unlike that accompanying disease of the external eye, is apparently not caused by any marked pain nor discomfort, but is an attempt to maintain partial dark adaptation of the retinal rods.

(4) The adaptation curve, showing the thresholds during dark adaptation following exposure of the eye to light of high intensity, differs from normal. The normal curve has two distinct portions; in the first section the thresholds depend upon cone function, in the second upon rod function. In typical achromatopsia only a rod curve is present throughout the entire period of dark adaptation. The thresholds during the first 8 to 10 minutes are consequently higher than those of the normal eye.

In a small number of the reported cases of achromatopsia one or more of the associated characteristics are absent. In collaboration with Newhall in 1942[1] I reviewed the cases of atypical achromatopsia previously reported and described two additional atypical cases and one

* From the Department of Ophthalmology AAF School of Aviation Medicine.
† On leave of absence from the Wilmer Ophthalmological Institute of the Johns Hopkins University and Hospital, 1942-1945.

typical case. In one of the former there was complete loss of chromatic vision and a normal luminosity curve. In a second case there was incomplete loss of chromatic vision, normal visual acuity, no evidence of photophobia, and only a slight shift in the luminosity curve. In 1943, Lewis and Mandelbaum[2] reported three cases of achromatopsia in which adaptation curves were entirely normal, with two distinct portions such as are customarily attributed respectively to cone and rod response. The findings were typical in all other respects.

Present investigation

The present study reports an additional case of achromatopsia in which most of the typical associated findings were absent

lightest gray sample (N9/) was called white, N8/ and N7/ were called gray, N6/ gray or green, N5/ to N3/ green, N2/ and N1/ red. Eight loose samples, whose colors were red, orange, yellow, green, blue, and purple of high chroma (saturation) were then compared in turn with the neutral-value scale. In all but one case it was possible for the subject to find a gray which matched the color exactly. In this one case he reported that the color was slightly darker than N5/. The neutral grays chosen to match each color and the color name assigned in each case are given in table 1. It will be noted that the subject was quite consistent in applying the name red to low-value (dark) colors and grays, the name green to colors and grays of medium value, and the name

TABLE 1

Colors of Following Munsell Specifications			are Matched to Grays of these Values	and Called by these Color Names
Hue	Value	Chroma		
Red	4	12	3	Red
Red	5	12	4	Green
Yellow red	6	12	6–7	Green
Yellow	8	12	8	Gray
Green	5	8	6	Green
Purple blue	3	12	4	Green
Purple	4	12	5–	Green
Red purple	4	12	4	Green

The subject was attached to a ground crew in the Army Air Forces. Complete loss of chromatic color perception was suspected from the findings on routine color-vision tests. He had some difficulty in reading the demonstration plate in the American Optical Company charts (a red 12 on a gray background) and had the unusually low score of 2 on the Color Threshold Test.[3]

Further tests with Munsell colors gave conclusive evidence of achromatopsia. When the subject was shown the neutral value scale in the Munsell Atlas, the

gray to light colors and grays (of high value). The value matches indicate also that reds appeared darker, greens and blues lighter than they do to the average normal eye. The reds, for example, were matched to grays which are to the normal eye, one step lower in value, the greens, blues, and purples matched to grays one step higher in value.

A further series of color matches was made using the Macbeth Illuminometer. The illuminometer was directed toward an opal glass plate illuminated from the rear to a brightness of 263 ml. Each of

the colored filters was interposed in turn between the illuminometer and the opal glass. By adjusting the brightness of the standard field of the instrument, the subject was able in every case to obtain a perfect match between the white and the chromatic photometric fields; that is, they were reported as identical in color as well as in brightness. Columns 1 and 2 of table 2 give the Corning filters used and the color of the comparison field in each case. Column 3 gives the brightnesses of the comparison field as determined by an observer with normal color vision; column 4, the brightnesses as determined by the subject. After the standard and comparison fields were matched by suitable adjustment of the brightness of the latter the subject in each case reported that the two fields were identical. The color names assigned to the photometric field, as before, varied with the brightness and tended to be reported as gray when above 50 ml., and as green when below this value. A comparison of the brightness matches with those of the normal subject again shows that red and orange appeared darker than to the normal eye, green and blue lighter.

TABLE 2

Filter Used	Color of Comparison Field	Brightness as Measured by Normal ml.	Brightness as Measured by Subject ml.	Color of Field Reported by Subject
None	White	263.0	253.0	Gray
Corning 5543	Blue	5.64	13.0	Green
Corning 4084	Green	39.8	51.4	Gray
Corning 3482	Orange	160.0	103.0	Gray
Corning 2412	Red	36.9	8.03	Gray "too light to be green"
Corning 2404	Red	17.9	3.21	Probably green

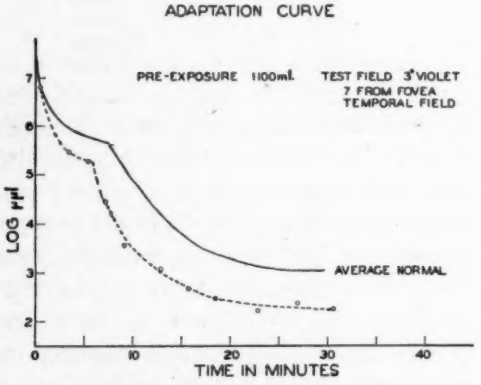

Fig. 1 (Sloan). Adaptation curve measured on the Hecht Adaptometer with a 3-degree violet test field.

From these data the extent of the shift in the spectral-luminosity curve can be estimated only. The decrease in relative luminosity of reds and increase in that of blues and greens is not so great as would be expected if the luminosity curve of the spectrum coincided with the normal scotopic curve. It is of interest in this connection that the subject's affection would be classified under protanopia on

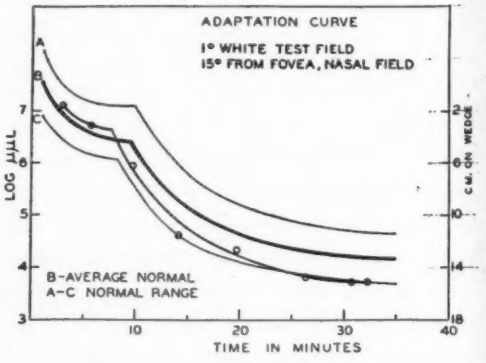

Fig. 2 (Sloan). Adaptation curve measured on the Perimetric Light Sense Tester.

the basis of tests with the Rabkin Polychromatic charts, presumably because in these charts the difference in brightness between figure and background was the same for him as for one who is protanopic, and suggests that the shift in the spectral-luminosity curve corresponds to that found in protanopia.

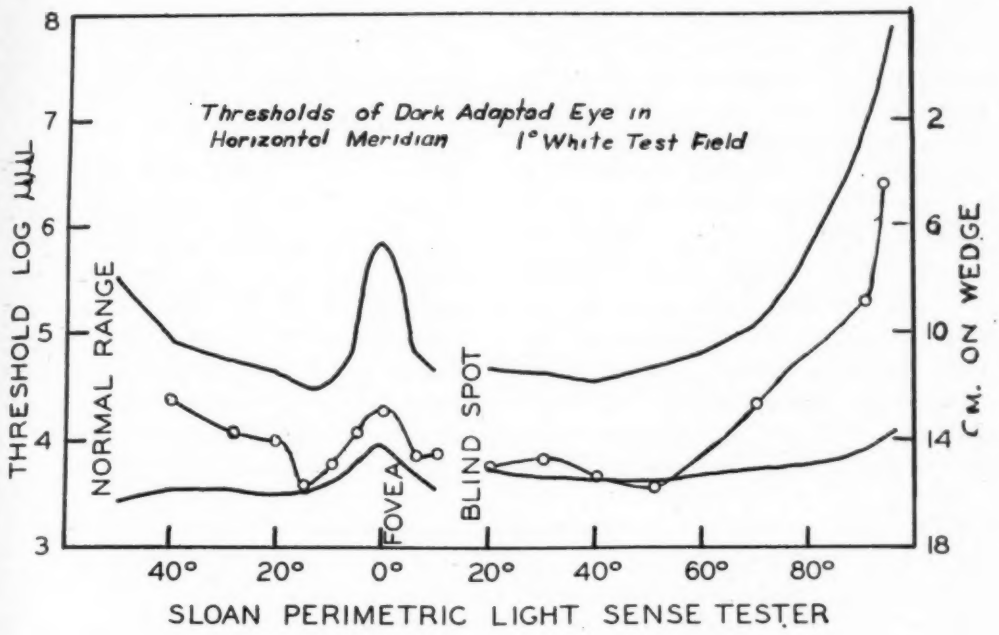

Fig. 3 (Sloan). Thresholds of fully dark-adapted eye from center to periphery in the horizontal meridian.

All other characteristics commonly associated with achromatopsia were absent in this subject. The corrected visual acuity was 20/15 in each eye. There was no evidence of photophobia. The curve of dark adaptation after preëxposure to high brightness had the usual cone and rod portions.

Figure 1 shows the adaptation curve measured on the Hecht Adaptometer with a 3-degree violet test field. Figure 2 shows the adaptation curve measured on the Perimetric Light Sense Tester[4] with a 1-degree white test field. Both curves have distinct cone and rod portions, and rod thresholds lower than the average normal values. Figure 3 gives the thresholds of the fully dark-adapted eye from center to periphery in the horizontal meridian. These were also measured on the Perimetric Light Sense Tester with a 1-degree white test field. The thresholds are unusually low except in the far periphery, where they are close to the average normal values.

As in normal subjects, the foveal threshold was higher than that of the surrounding regions. Additional deter-

TABLE 3

FOVEAL THRESHOLDS LOG μμL 1-DEGREE TEST FIELD

	Subject	Normal	Normal
1° white	6.24	6.05	5.58
1° red	7.39	5.55	5.29
1° blue	5.04	6.16	5.53

minations of the foveal threshold measured on the Hecht Adaptometer are given in table 3 for the subject under consideration and for two normal subjects. The fixation control was a dim point of light at the center of the 1-degree test field. This device maintains a more accurate control of fixation than does the perifoveal fixation target of the Perimetric Light Sense Tester, but the presence of the fixation light may increase the threshold slightly. The threshold for white light was not significantly different from the thresholds of the two normal subjects. The threshold for red was, however, higher and that for blue lower than the corresponding thresholds of the normal subjects. These results are consistent with the previous findings, which indicated a shift in the spectral-luminosity curve toward the short-wave-length end.

The normal visual acuity and the normal foveal threshold for white light indicate that the visual cells of the fovea in certain respects function as cones rather than as rods. They differ from normal cones in having a spectral-luminosity curve intermediate between the cone and rod curves, and resemble rods in their complete lack of color discrimination.

Summary

Studies are reported of a subject with complete loss of color perception and a shift in the spectral-luminosity curve. Other evidences of abnormal cone function were not found. These results and those of previous investigations indicate that no one of the characteristics commonly associated with typical achromatopsia is invariably present.

Wilmer Ophthalmological Institute.

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OCULAR LEPROSY IN PANAMA

A STUDY OF 150 CASES

R. D. HARLEY, LT. COL (MC), A.U.S.
Ancon, Canal Zone, R. de P.

The subject of leprosy has attracted medical writers since the earliest times. Accounts from the Egyptian papyrus tell of a disease resembling leprosy that was evident as early as the reign of Hesepti of the First Dynasty about 4600 B.C.;[1] the Papyrus Ebers shows that it existed in Egypt in 1500 B.C. Numerous references have been made to it in Biblical times regarding diagnosis and prevention, where it was referred to as "Zaarath." "Zaarath" has no doubt been misinterpreted by the translators of the Bible. Outstanding symptoms such as anesthesia, contractures, nodular formations are not mentioned. The "rising" by which is probably meant eruption of any skin lesion, depigmentation, scaling, and itching are more suggestive of vitiligo, favus, psoriasis, scabies, or the acute exanthemata, the "risings" of which later would disappear after the specified period of isolation. Leprosy as we know it today probably did not exist among the ancient Hebrews. That the disease continues to stir curiosity and thought is a testimony to the bizarreness of the disease. Anyone who has worked with these patients is struck by the pathologic museum that resides in each one of them and the utter relentlessness of the disease process.

Reports in the literature on ocular leprosy have come from nearly all parts of the world where leprosy is found, yet there has been little reported in the past few decades. Leprosy was probably introduced to Panama early in the sixteenth century by the Spanish Conquistadores and later in the slave traffic. It is said that the disease first appeared in the United States about 1750 in the vicinity of what is now Louisiana. The improvement in our precision instruments for study and the apparent variation in leprosy of the eye in other parts of the world has prompted this study of 150 cases in Panama.

The patients reside, or have resided, in the Palo Seco Leper Colony and present all the observed cases of leprosy in Panama and the Canal Zone at the present time. The census of the colony maintains itself at about 120, since the number of new cases and the number of deaths nearly balance. There are about 10 postmortem examinations each year on patients from the colony. The superintendent of the leper colony believes that the total number of leprosy cases in Panama probably runs three or four times this number. The chance that these undiagnosed cases in the "Interior" will come under the recognizing eye of a physician is small, since their medical facilities are limited.

As Ophthalmologist to the Palo Seco Leper Colony for the past 3½ years, I have been able to observe the ocular lesions in all stages. Accurate reports have been kept of the visual acuity, and refractions have been done as indicated. Examinations of the face, lids, conjunctivas, lacrimal apparatus, and extraocular motility were made. Loupe and biomicroscopic studies of the irides and corneas, and inspections of the fundi were routinely performed. Smears from the conjunctivas and corneas were examined in 100 cases. Data were collected as to place of birth, race, age, duration, and classification of leprosy in each instance. Accurate reports on the eye are traceable

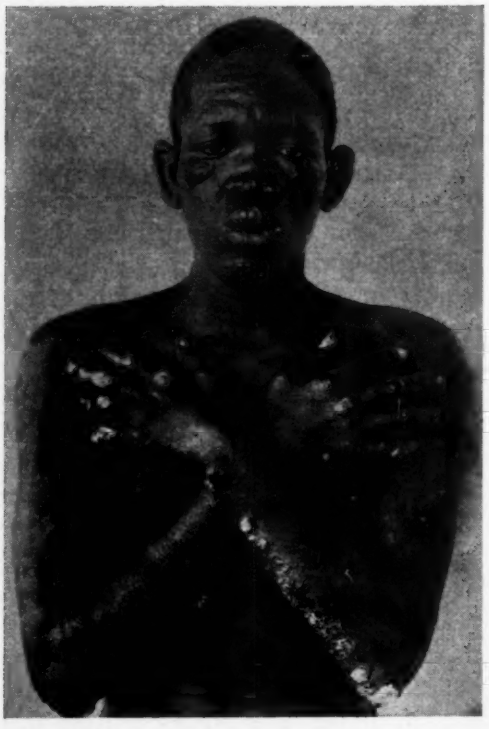


Fig. 1 (Harley). Mixed leprosy (moderately advanced).

Fig. 2 (Harley). Mixed leprosy (far advanced).

back to 1937, and these data have been included.

Different forms of treatment were tried in conjunction with systemic therapy. Over 25 operations were performed, including 5 enucleations. Histopathologic study has been made of 7 sectioned eyes. Photographs, lantern slides, and movies were made of the more interesting cases.

Fig. 3 (Harley). Nodular leprosy.

General characteristics, Distribution, and Age

The bacillus of leprosy, discovered by Hansen in 1874, which is found in nearly all the major lesions, is presumptive evidence of its role as the etiologic agent. *B. leprae* can usually be demonstrated in all the eyes at postmortem examination, especially in the anterior segment. The bacillus is an acid-fast slightly curved or straight rod, is said to be resistant to drying, extremes in temperature, and other unfavorable conditions.

The bodies of lepers which have been dug up after three and four years yield *B. leprae* in profusion.[2] Arning, in Honolulu, found bacilli in great numbers in the putrid fluids of a cadaver that had been exhumed, three months after burial.

The leprosy bacillus, pathologically, induces a typical granulomatous lesion which manifests itself either as a nodular mass or a diffuse infiltrative process. The disease ordinarily assumes three forms: nodular, anesthetic, or mixed.

Nodular. This form affects all the cutaneous structures, especially the face. The leproma is made up of lymphocytes, fibroblasts, and large monocytes, with an occasional polymorphonuclear cell. The large monocytes phagocytize the leprosy bacilli, become swollen, and then take on the characteristics of "foam cells," due to the frothy appearance of the cytoplasm. These foam cells may aggregate into large multinucleated giant cells (lepra cells). However, there is no focal arrangement, and caseation does not occur, but fibrosis with shrinkage does occur.

Anesthetic. In this form there are usually no foam cells but there is an infiltration of the perineurium and endoneurium by lymphocytes, fibroblasts, and monocytes. Eventually fibrosis occurs, which destroys the nerve tissue by pressure.

Mixed. This form is a combination of the two, but manifests itself clinically in varying degrees of the nodular and anesthetic forms.

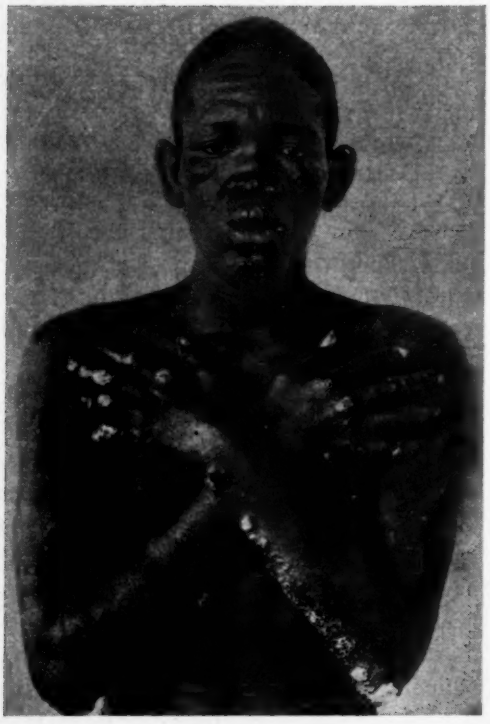
Two other types—namely, the macular and tuberculoid forms—exist, but their recognition is less clear cut and does not concern the present subject.

According to Manson-Bahr, 1935,[3] nodular leprosy is more common in cold damp climates, whereas nerve leprosy occurs more frequently in warm dry climates.

In our cases none of the purely nodular

Fig. 4 (Harley). Neural leprosy.

Fig. 5 (Harley). Tuberculoidlike lesions in a case of mixed leprosy.



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type was found. Twenty-six percent were classified as anesthetic, and 74 percent were mixed. The patients were classified as to place of birth, since there is strong evidence that the disease is contracted during childhood. It was interesting to note that the vast majority of patients from Panama in the past 20 years have come from two relatively localized areas in the interior of Panama; namely, Los Santos and Bocas del Toro.

Positive serology

In only three patients was syphilis definitely proved by a history of chancre, a positive darkfield examination, a positive spinal fluid, or other incontrovertible evidence. However, sera from a relatively large number of patients showed a 1- or 3-plus Kahn reaction and often a less positive Wassermann. The incidence of proved syphilis at Palo Seco is lower than that usually given for Negro and mestizo individuals in Panama from the same stratum as that from which the lepers came. Positive blood tests of Negroes and mestizos from 1924 to 1941 varied between 15 percent to 30 percent[4] according to the year. However, it is probable that a considerable number of these persons had a positive reaction from other causes.

Each leper patient had at least five or six blood tests for syphilis, but the tests varied considerably in their positiveness and often became negative for both the Wassermann and Kahn. Nearly all the nodular cases (that is mixed) showed a positive blood test for syphilis at one time, usually picked up by the Kahn test. The neural cases, it was found, were less likely to give a positive test unless there was an acute tuberculoid reaction. Syphilis, apparently, does not alter the course of leprosy except, perhaps, to involve some structures which leprosy ordinarily does not attack.

Immunity in leprosy

The question of allergy has been investigated, but, as in the use of tuberculin, there are certain breaches in its interpretation which are difficult to comprehend fully and apply clinically.

Rotberg[5] studied the reactions to Lepromin (antigen from nodules) in 1,529 individuals. He concluded that leprosy is a highly contagious but also a highly immunizing disease. The bacillary leper is the propagator of the infection, but prolonged contact with this type of case does not necessarily mean that the disease can be contracted. In countries where it is endemic a large part of the population has been contaminated and immunized. A predisposition to leprosy exists which is represented by a failure of reaction of the immuno-allergy to the bacillary invasion. The greater ratio of cases of "declared" leprosy in familial foci is due, probably, to inherited predisposition, to superinfections, and to the endemic zone of environment. There seems to be little doubt, at present, that susceptibility to the disease varies greatly in different individuals. Healthy adult individuals with good nutrition appear relatively immune to leprosy.

Distribution of patients according to place of birth

Country	*Percentage*
Panama	70
Jamaica	10
Colombia	5
Costa Rica	5
Barbados	3
China	1
Guadaloupe	1
Haiti	1
Martinique	1
Nicaragua	1
St. Lucia	1
St. Vincent	1

The youngest patient examined at Palo Seco was 12 years of age and the oldest 85. In general, the patients who had had the disease for a considerable period of time showed the most severe ocular complications. In fact, it may be said that these patients uniformly showed varying degrees of ocular leprosy proportional to the length of their illness. Those who apparently contracted the disease later in life, or in whom it became manifest later, showed distinctly milder and less rapid ocular changes. Although there was a majority of males at the colony, no actual sex difference could be recognized. Approximately 10 percent of the patients became "smear negative" and were paroled, but 50 percent of these returned to die with the disease. Some of the patients who became eligible for parole declined to leave, preferring the "easy going" routine life of the colony to the struggle of the outside world.

Ocular involvement

Reports from the literature show that the eye is frequently involved in the systemic disease process. It seems to be generally agreed that the eye presents a very real and serious complication in leprosy. However, the percentage of cases showing ocular involvement, as recorded, varies from 20 to 100 percent of all patients when the different forms of the disease are taken into account (Neve,[6] Minder,[7] de Barros,[8] Wood,[9] Borthen and Lie,[10] and others). It is probably true that the disease assumes different rates of incidence and manifestations in outlying parts of the world, and this may account for the variations in the reports that have been published. It is known, for instance, that leprosy appeared in Europe about the sixth and seventh centuries and apparently spread with the Crusaders. By the twelfth and thirteenth centuries it spread with nearly epidemic proportions, so that it was known throughout Europe. At the end of the sixteenth century, through the efforts of segregation, it was considered to have nearly died out. Practically any disease introduced to a virgin people may be expected to be more serious and entail extensive complications; so it may be with the ocular complications of leprosy in different countries.

It was noted that the lowest percentages of ocular involvement emanated from the older civilizations although the significance of this may be questioned. Some authors state that all leprous patients will eventually have ocular complications. Grossman[11] stated that patients with cutaneous (nodular) leprosy always have ocular complications. Pinkerton[12] in Hawaii and Prendergast[13] in Louisiana reported involvement of the eyes by leprosy in approximately 91 percent of cases.

At Palo Seco the figures corresponded almost exactly with those of the last two authors. Ninety percent of the leprous patients were found to have ocular involvement, not including the adnexa. If the adnexa were included it may be assumed that in predominantly nodular leprosy all but those in the first few years of their disease have involvement about the eyes. It seems likely, as has been stated, that some form of ocular leprosy will eventually occur if the patient lives long enough. The 10 percent of eyes free from the disease were found exclusively in recent or paroled patients. It was impressive to note that of all the organs involved in leprosy the ocular lesions appeared to cause more complaints than any other.

Lopez[14] calls attention to the dullness of the leper's eyes. It is indeed an observation of some value. The eyes seem to have a dull, lusterless, expressionless ap-

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St. Lucia	1
St. Vincent	1

The youngest patient examined at Palo Seco was 12 years of age and the oldest 85. In general, the patients who had had the disease for a considerable period of time showed the most severe ocular complications. In fact, it may be said that these patients uniformly showed varying degrees of ocular leprosy proportional to the length of their illness. Those who apparently contracted the disease later in life, or in whom it became manifest later, showed distinctly milder and less rapid ocular changes. Although there was a majority of males at the colony, no actual sex difference could be recognized. Approximately 10 percent of the patients became "smear negative" and were paroled, but 50 percent of these returned to die with the disease. Some of the patients who became eligible for parole declined to leave, preferring the "easy going" routine life of the colony to the struggle of the outside world.

Ocular involvement

Reports from the literature show that the eye is frequently involved in the systemic disease process. It seems to be generally agreed that the eye presents a very real and serious complication in leprosy. However, the percentage of cases showing ocular involvement, as recorded, varies from 20 to 100 percent of all patients when the different forms of the disease are taken into account (Neve,[6] Minder,[7] de Barros,[8] Wood,[9] Borthen and Lie,[10] and others). It is probably true that the disease assumes different rates of incidence and manifestations in outlying parts of the world, and this may account for the variations in the reports that have been published. It is known, for instance, that leprosy appeared in Europe about the sixth and seventh centuries and apparently spread with the Crusaders. By the twelfth and thirteenth centuries it spread with nearly epidemic proportions, so that it was known throughout Europe. At the end of the sixteenth century, through the efforts of segregation, it was considered to have nearly died out. Practically any disease introduced to a virgin people may be expected to be more serious and entail extensive complications; so it may be with the ocular complications of leprosy in different countries.

It was noted that the lowest percentages of ocular involvement emanated from the older civilizations although the significance of this may be questioned. Some authors state that all leprous patients will eventually have ocular complications. Grossman[11] stated that patients with cutaneous (nodular) leprosy always have ocular complications. Pinkerton[12] in Hawaii and Prendergast[13] in Louisiana reported involvement of the eyes by leprosy in approximately 91 percent of cases.

At Palo Seco the figures corresponded almost exactly with those of the last two authors. Ninety percent of the leprous patients were found to have ocular involvement, not including the adnexa. If the adnexa were included it may be assumed that in predominantly nodular leprosy all but those in the first few years of their disease have involvement about the eyes. It seems likely, as has been stated, that some form of ocular leprosy will eventually occur if the patient lives long enough. The 10 percent of eyes free from the disease were found exclusively in recent or paroled patients. It was impressive to note that of all the organs involved in leprosy the ocular lesions appeared to cause more complaints than any other.

Lopez[14] calls attention to the dullness of the leper's eyes. It is indeed an observation of some value. The eyes seem to have a dull, lusterless, expressionless ap-

pearance even before notable ocular pathologic change is apparent. Perhaps this is just an outward expression of the greater or lesser degree of depression which inevitably accompanies this disease process.

It was noted that the most severe ocular involvement occurred in those patients who had extensive nodular development. In our series all these cases were classified as mixed, since there were no cases in the colony which could be diagnosed as purely nodular. Even in the anesthetic cases of long duration the ocular pathologic change seemed to be less severe.

Acquisition of the disease

Even though the organism and pathologic lesions present in leprosy have been accurately described, there is, as yet, no definite idea of how the disease occurs, except that it is probably contagious. The fact that it seemed to run in families led the early leprologists to believe that the disease was hereditary. Of the numerous offspring of Norwegian lepers who emigrated to America, seven definite cases of leprosy occurred in the first generation and one of doubtful diagnosis in the second generation. It is noteworthy that although acid-fast bacilli have been detected in the placenta and cord, no children have been known to develop leprosy if removed from the parents at birth. At Palo Seco the patients are allowed to marry within the colony. The children who have resulted from these unions are known to be thus far free from the disease. The evidence is that the disease is not hereditary.

Authorities now believe that leprosy is transmitted by contagion, usually in childhood. However, the factors influencing contagion appear to vary within wide limits. A number of years must intervene, apparently, between contact of the susceptible host and the manifest disease. Pinkerton[15] stated that after the first leprous lesion had been noted there was an average of two years of freedom before the patient became a menace to the community and was apprehended and quarantined. Many attempts have been made to transfer leprosy to man by inoculation. Most of the trials have been futile, but in one experimental and in several accidental inoculations there were positive reactions. The disease, in these instances, appeared milder and was apparently self-limited. Another case of inoculation was in a Sandwich Islander, who within a month developed a leprotic neuritis followed by death within six years. It was revealed that members of his family were lepers, so this finding nullified the experiment (Manson-Bahr[3]). Father Damien's (Molokai Island) was one of the few adult cases of contagion through contact on record, but even in his case the evidence was not complete.

Not only is the method of transmission in dispute but there is still much speculation as to the medium of transfer. The portal of entry for the ocular invasion is also in question. It is believed by some that the bacilli enter the eye externally from the conjunctiva or episcleral tissues. Most workers are of the opinion that the ocular infection is secondary to a hematogenous spread. The fact that the bacilli can be found in nearly all the internal organs is an outcome of the bacillemia which occurs in most cases of cutaneous leprosy. The "acute leprosy reaction" accompanied by high fever is probably a bacillemia. In favor of the hematogenous spread to the eye is an article by Fuchs,[16] who found the primary ocular lesions in the anterior part of the ciliary body and major circle of the iris. This region has a rich vascular plexus such as would be a convenient receiving end organ for the bacilli. Fuchs found that bacilli may appear in healthy tissues

but did not necessarily affect the tissues. The behavior of the tissues toward the bacilli was the decisive factor. In five sectioned eyes it was shown that inflammation occurred in the perilimbal episclera and the longitudinal fibers of the ciliary muscle extending back to the ora serrata but no farther. Occasionally, healed chorioretinitis occurred, but this was unaccompanied by bacilli, thus casting doubt on its leprous origin. In all cases the cyclitis appeared to be an older inflammation than the episcleritis, which added to the evidence of an endogenous spread.

Santonastaso[17] in studying eight sectioned eyes was chiefly concerned with the localization and extent of the ocular pathologic process. Assuming that there was an exogenous spread of bacilli into the eye and that the limbus was the site of selection, it might be expected that the oldest and most advanced pathologic change would occur at the limbus. This, however, does not seem to be the case, for frequently the iris and ciliary body were more advanced pathologically, thus suggesting an endogenous origin for this site. There appeared to be two factors, exogenous and endogenous, which seemed to be acting simultaneously in this disease. In some eyes one factor often predominated over the other, so that pathologically the response of the ocular tissues to the bacilli differed in age and extent. On the contrary, because other workers have been unable to find bacilli in the small vessels of the iris or ciliary body they have raised objection to the theory of blood-borne transference. Santonastaso has correlated the presence of argentophile fibers with the presence of leprous involvement in the eye. Argentophile fibers may be found especially in the submucosal layer of the bulbar and palpebral fold of the conjunctiva, uveal tract, ciliary muscle, iris stroma, pectinate ligament, Schlemm's canal, and about blood vessels. Since the leprous involvement closely followed the distribution or argentophile fibers they have been assumed to have a real significance. However, the cornea is peculiarly lacking in these fibers. It is believed that the cornea is attacked secondarily and suffers chiefly through a toxic or trophic agent. This observation, though attractive, appears to be a coincidence rather than a reality. The disease primarily strikes the anterior segment of the eye, and it is in this region that bacilli are most often encountered. The argentophile theory makes it difficult to account for the scarcity of the disease in the posterior segment, where uveal tissues (argentophile fibers) are prominent.

Dimitry[18] and others have called attention to the high percentage of ocular cases that showed marked nasal pathologic change. The cases at Palo Seco exhibited the same association. It is unusual to see any pronounced ocular complication not accompanied by varying degrees of nasal mucous-membrane ulceration and perforation. The possibility of an ascending infection by way of the nasolacrimal duct is to be considered, but purulent dacryocystitis is not seen as commonly as might be suspected, even though the cartilaginous portion of the nose is completely depressed.

Vision and involvement in author's series

Vision and visual loss

In the series of 150 patients, the number of eyes examined constituted a total of 298. Twenty, or approximately 13 percent of the patients, were found to be totally blind in one or both eyes. Sixty-two, or 41 percent of the patients, had vision of 20/200 or less in one or both eyes, not correctable, which, in most in-

Fig. 6 (Harley). Corneal leproma in mixed leprosy.

stances, may be assumed to be due to the disease. In 65, or 43 percent, there was normal vision in both eyes. Sixteen, or approximately 10 percent, had normal vision in one eye. The normal vision of these patients had no bearing on the pathologic change, which was later recognized by slitlamp observation. It is impressive that the gross appearance of the eyes in so many of these cases was disproportionate to the findings by biomicroscopy. Thus 82, or 54 percent, of the patients were blind or had vision of 20/200 or less in one or both eyes. This

Fig. 7 (Harley). Close-up view of corneal leproma in mixed leprosy.

may be regarded as the percentage of the colony with severe ocular complications of leprosy. Neve[6] found 13 blind eyes in 80 patients in India, and Van Driel[19] collected but 7 cases of blindness in 1,300 cases examined in Sumatra. Certainly the factor of blindness must vary with nutrition, environment, stage of the disease, and medical care.

The adnexa of the eye

Leprosy involves the region of the eyebrows and eyelids with considerable frequency. Because this is true such involvement is probably one of the best-known signs recognized by physicians and laymen alike.

Approximately 50 percent of the patients had hypertrophy of the skin of the brows or cutaneous nodules, with varying degrees of loss of hair of the eyebrows or lashes (madarosis). This represented the percentage of patients with far-advanced nodular leprosy. Although loss of the eyebrows and eyelashes is usually given as an early and characteristic feature of the disease, this condition, as a rule, has been found in only the most developed cases. It cannot be regarded as an early sign. The hair changes begin with slight loss in the temporal regions of the eyebrows. Sometimes they become gray, splintered, or softly filamentous. The eyebrows are usually lost before the eyelashes. Frequently a few fine eyelashes persist until the last, especially along the lower lids.

In nodular leprosy, formation of nodules about the outer eyebrows is common. This spot, in addition to the ear lobes, serves as an excellent place to make a puncture for serum smears in the diagnosis of the disease. The margin of the eyelid, usually the upper, may be attacked by nodules. Sometimes these closely resemble chalazia and commonly cause localized pain. Lepromas, the size of large

peas, were found at the margins of three lids. These nodules may ulcerate. A diffuse infiltration of the eyelid margins was also seen which gave the edges a rolled thickened appearance (tylosis). Nodules are also commonly situated about the alae of the nose, on the cheeks, forehead, lips, and ears. The nodules, as they increase in size, seem to accentuate the normal skin folds and wrinkles until there develops what everyone knows as "leonine facies."

In anesthetic leprosy isolated areas of diminished or absent sensitivity occur in the skin about the eyes. They may usually be recognized by differing slightly in color from the rest of the skin. In 15 cases or 10 percent, there was paresis of the orbicularis palpebrarum (lagophthalmos), to the extent that there was incomplete closure of the lids. Fully another 10 percent of patients showed weakness of lid closure when attempt was made manually to elevate the lowered upper lid. In each case the involvement was bilateral but differed in intensity between the right and left side. The cases exhibiting lagophthalmos were in the purely neural and mixed types alike. Sometimes the entire peripheral seventh nerve on one side was involved, with the typical deformity, but it invariably seemed to affect the mobility of the lids to a greater extent. A search was made in each case for a nodule over the affected nerve branch, but none was ever demonstrable. The affection appeared to be a pure neural one and curiously involved the lids out of proportion to the other structures. With the lagophthalmos occurred relaxation and atonicity of the lower lids, commonly resulting in a paralytic ectropion. Ectropion was found in 11 of the 15 cases of lagophthalmos. In the other cases eversion of the lower lid will doubtless develop as time goes on. Exposure keratitis, excessive lacrimation with tears spilling down the cheeks, and loss of the natural protective barrier which the lids afford are the usual sequelae of such a complication.

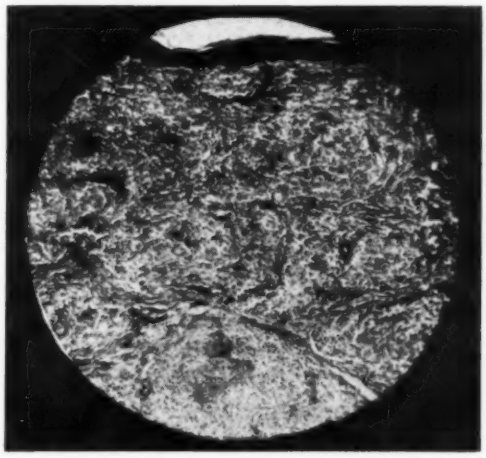

Fig. 8 (Harley). Section of leprous skin. Masses of epithelioid cells and lymphocytes have collected beneath the surface epithelium.

Certain areas of the skin which appear to be free from nodules in skin leprosy have been noted. One of these is located in the upper and lower folds of the lids.

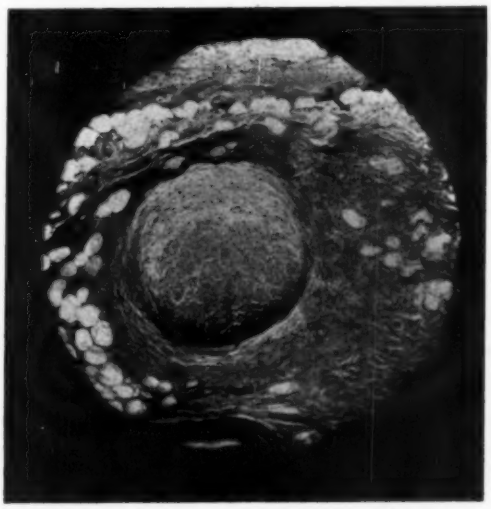

Fig. 9 (Harley). Section of peripheral nerve. Perineural and endoneural cellular infiltrations which are gradually being replaced by connective tissue.

No nodules were ever found in these folds, which are protected so well by the orbital rim. The protection thus afforded to these skin areas appears to play a dominant role and suggests itself strongly as a prophylactic measure. This protective measure has also been advocated by Valle.[20] At Palo Seco, where there is a predominance of the Catholic faith, it has been noted that particularly troublesome nodules have developed just below the knee. Apparently trauma as well plays a role in the formation of nodules.

Prendergast[13] pointed out the relatively common occurrence of xanthelasma of the adnexa among lepers. This condition was found to be associated with a disturbed cholesterol metabolism. No xanthelasmas were seen in our patients, though perhaps the nearly universal dark pigmentation made this condition less recognizable.

A purulent dacryocystitis was seen in four cases but it is suspected that involvement of the tear sac is much more common than this figure would indicate. Stricture or other occlusive phenomena of the nasolacrimal duct which leads to a frankly manifest tear-sac infection is probably always secondary to nasal pathologic change. The complete collapse of the tip of the nose seemed to cause fewer complete duct obstructions than might be imagined.

Conjunctiva

A chronic conjunctivitis occurred in 60, or 40 percent, of the 150 patients, whereas in only 20 percent was the discharge sufficiently annoying to evoke complaints from the patient. The conjunctivitis in all instances closely resembled a chronic catarrhal type with profuse mucopurulent discharge. In the other 20 percent the conjunctivitis consisted chiefly of a chronic injection of the conjunctival vessels, especially in the exposed portion between the lids and about the limbus. The ease with which far-advanced patients could tolerate the profuse mucopurulent secretions was probably due to the partially diminished sensitivity of the conjunctiva and cornea which occurs in individuals with lagophthalmos in the neural and mixed types of leprosy. However, complete absence of sensation of the conjunctiva was never demonstrated.

Duke-Elder[21] states that nodules appear with great frequency in the conjunctiva in the nodular and mixed forms. However, Pinkerton and Prendergast express the opinion that the conjunctiva shows little involvement and appears to be one of the fairly immune ocular tissues.

Only two lepromatous plaques were found in the series of cases studied at Palo Seco. These occurred on the palpebral conjunctiva of the upper lid in conjunction with a particularly severe conjunctivitis as flat, infiltrated, irregularly circular areas with an ulcerated center. Leproma of the limbus will be considered with the involvement of the cornea.

Conjunctival smears were made from the inferior cul-de-sac in 100 cases. Eight smears were found to contain acid-fast bacilli. Fuchs mentions that Arizumi found bacilli in the tears of 66 percent of the patients. Riad[22] found the lacrimal secretion negative in 108 cases as did Rogers and Muir[23] and Van Driel in their cases. The wide variation in these findings suggests that the bacilli may occur in the conjunctival secretions as an incidental finding from the skin and nasal secretions, internally from the episcleral tissues about the limbus, or from the blood stream. One fact remains clear, however; namely, that the conjunctiva is apparently more immune than the other ocular structures.

Thirty, or 20 percent, of the eyes contained pterygia which for the most part had an atrophic type of head and did not require surgical treatment. They appeared more prominent, owing to the conjunctival injection. Considering the relative frequency with which pterygia occur in the general population throughout Panama, the question of its presence as a complication may be dismissed. One patient showed near the temporal limbus a Bitot's spot which disappeared following the administration of vitamin A for 10 days.

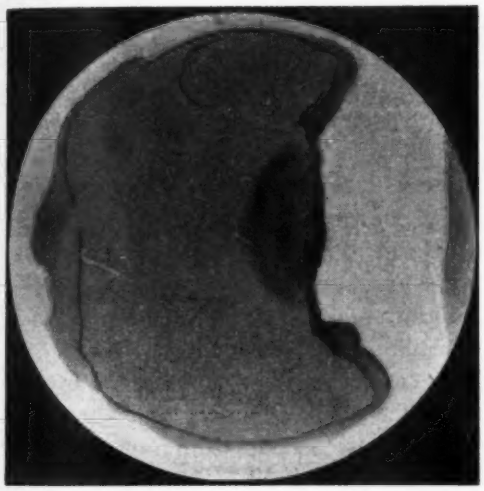

Fig. 10 (Harley). Leprous keratitis and iridocyclitis.

Cornea

The cornea appeared to be the most vulnerable of the ocular tissues that succumbed to leprosy. Involvement of this structure was recognized in 87 cases and frequently was the only site in which any pathologic change could be seen. Elliot[24] and other investigators have classified three principal lesions: (1) pannus or infected granulation tissue which extends in from the limbus, (2) a superficial punctate keratitis and, (3) a deep interstitial keratitis.

The most commonly observed corneal lesion was superficial keratitis, which occurred in over 34 percent of all cases. This usually began as a light milky haze punctuated by tiny white dots at the superior or superior-temporal limbus. The lower margin was usually well delineated by a wavy line, and the whole involved area gave the impression of finely pulverized "chalk" or "flour" dust, as has been described by other observers. The lesion showed a generalized haze into which were sprinkled tiny aggregations

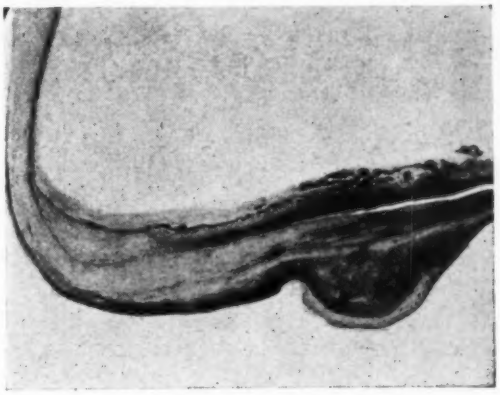

Fig. 11 (Harley). Small leproma of the cornea. Note the cellular infiltration beneath the corneal epithelium.

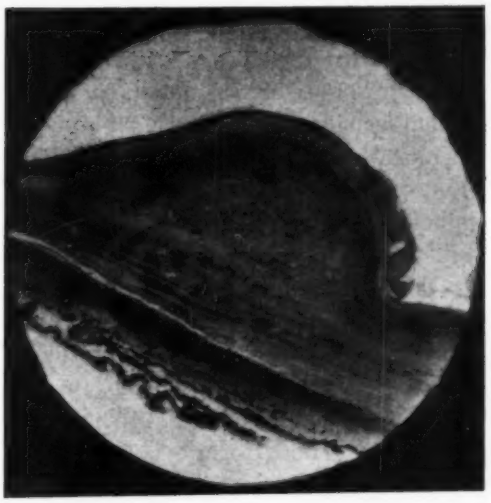

Fig. 12 (Harley). Corneal leproma. Higher-power view of figure 11.

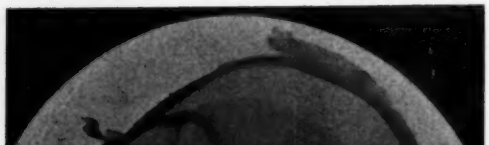

Fig. 13 (Harley). Leprous interstitial keratitis. Note irregular thickening and iris atrophy.

of pinpoint white dots. Many small vascular loops often crossed the limbus to enter the lesion beneath Bowman's membrane. In the majority of corneas the lower limit was 2.0 to 3.0 mm. above the pupillary center of the cornea, so that vision was not impaired and the patient was unaware of the lesion hidden by the upper lid. These lesions were also observed to arise from the nasal and inferior limbus. The superficial keratitis of leprosy may be easily overlooked. It is hidden under the upper lid and usually requires good light and magnification such as a slitlamp provides. Trantas[25] describes an epithelial and subepithelial keratitis. The former is transient and disappears in a few days, leaving the subepithelial form which is so commonly observed. That both forms are simply phases of the well-known superficial leprous keratitis needs no further substantiation. The latter term should be used to cover both forms. This form of superficial punctate keratitis may be regarded as one of the most diagnostic lesions of ocular leprosy—the other being the tiny lepromata occurring in the iris, which will be referred to later.

Histologic examination of these corneas showed aggregations of round cells and polymorphonuclears beneath Bowman's membrane, leaving the corneal epithelium fairly well intact. Lepra cells were identified; aggregations of lepra bacilli have been described (Suganumo and Hojo[26]). The lesions resemble those seen in cutaneous leprosy. The keratitis has been observed to thin out as it approaches the center of the cornea, which, perhaps, accounts for the good vision that often seems out of proportion to the corneal haze.

In 23 cases a frank interstitial keratitis was recognized. This appeared indistinguishable from luetic interstitial keratitis. King[27] states that such interstitial involvement does not tend to become less dense with time as does the luetic type. There were five other cases in which a grayish infiltration was present in the periphery, resembling an arcus senilis. However, in these cases vascular loops were present over the limbal border, and they may have represented the beginning of future interstitial keratitides. In 12 additional cases vascularization extending 1.0 to 2.0 mm. into the corneal substance was noted.

A frank pannus was recognized in

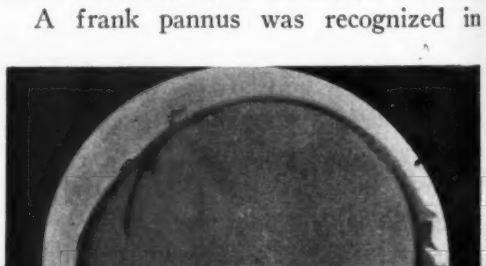

Fig. 14 (Harley). Larger leproma of cornea.

seven cases but was in no way different from the pannus seen in other conditions. The granulation was anterior to the cornea but destroyed it as the granulating mass descended. This was evidenced by the vascularization and area of infiltration that preceded it.

The most unusual lesion of the cornea was the giant leproma that occurred in three cases. In each instance it was engrafted on the cornea from a superficial keratitis and looked like a massive epithelioma. Scrapings from these lesions showed them to be teeming with lepra bacilli. Histologically, the corneal epithelium was epidermalized and occasionally ulcerated. Bowman's membrane was generally absent, and calcium deposits were present in its remaining fragments. Inflammatory granulation tissue intervened between the normal epithelium and substantia which was involved. Infiltrating the mass were lymphocytes, plasma cells, polymorphonuclears, and predominantly large foamy wandering cells. It has been suggested that the pathologic corneal changes represent different stages of the same process, and this may be true. Or, perhaps, the different corneal lesions are a result of the varying grades of "tissue resistance" to be found in the host. Six lepromas were situated at the limbus, a relatively frequent site, probably owing to the rich vascular supply at this location. Leprous keratitis is further characterized by its indolent nature without the usual inflammatory reaction.

Gabriélidès[28] and Pillat[29] found bacilli in superficial corneal scrapings and emphasized this point in the diagnosis of ocular leprosy. However, in our cases it was not possible to demonstrate bacilli in superficial scrapings where only the epithelium was removed. Bacilli were, of course, present in the cornea, but it was necessary to scrape to or include Bowman's membrane in order to show them easily. This point was borne out by their location histologically.

The "beading" of the corneal nerves seen under high magnification is an interesting sight and easily overlooked. It was found in five cases but may be more common than this.

Corneal anesthesia is stressed almost universally in the textbooks. Yet, on repeated testings, it was possible to demonstrate this satisfactorily in but two far-advanced cases, in which the eyes were phthisical. When a small wisp of cotton was used, a relative loss of sensation was shown in a small number of cases (5). Still, when the cornea was lightly touched with a sharpened toothpick a sensation of pain was easily evoked. In general, it would seem that in the cases observed at Palo Seco complete corneal anesthesia is a rarity. De Barros[8] of Brazil noted the same persistence of corneal sensation and suggested the need for uniform testing material, such as Von Frey's hair.

Uveal tract

Second only to the cornea, the iris is the structure most frequently involved clinically in ocular leprosy. The most common form of iritis is the chronic recurrent inflammation which insidiously recurs until the most severe sequelae have risen. It comes on typically at one- to six-month intervals, lasting one to three weeks at each attack, depending on the treatment instituted.

Iritis or its sequelae (posterior synechia, ectropion uveae, anterior capsular pigment deposits, or lepromas) were recognized in over 50 percent of the cases. It was usually bilateral and at about the same stage, although the acute recurrent attacks rarely involved both eyes at the same time, except when in conjunction with the "acute lepra reaction." This lepra

Fig. 15 (Harley). Iris angle in leproma section. Note the infiltration and atrophy of the ciliary body. The drainage angle is completely obscured.

Fig. 16 (Harley). Leprous iridocyclitis. The ciliary body is atrophic and the processes are edematous.

reaction is a hyperpyrexic state accompanied by cellulitis-like areas on the skin and supposedly a transient bacillemia. Van Poole[30] also noted the occurrence of iritis with the acute lepra reaction.

Iris atrophy is a common finding in the older cases. This is represented by a "flattening" of the iris pattern as a whole

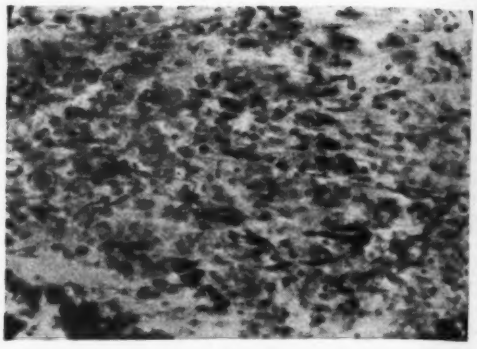

Fig. 17 (Harley). Leprous cyclitis. Within the ciliary body there are some rather large round and oblong basophilic vesicular bodies. These appear to be encysted and often included within multinucleated giant cells. Acid-fast stain reveals B. leprae in the encysted body.

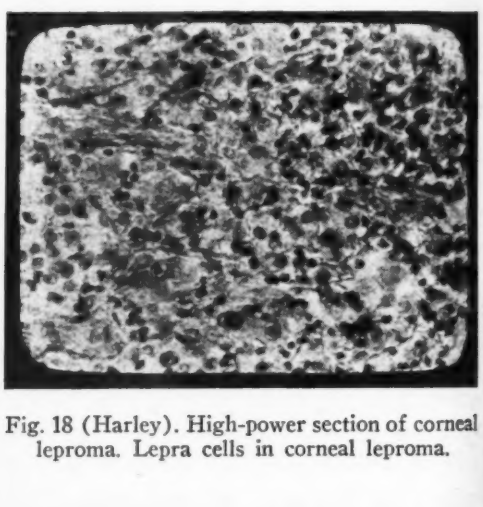

Fig. 18 (Harley). High-power section of corneal leproma. Lepra cells in corneal leproma.

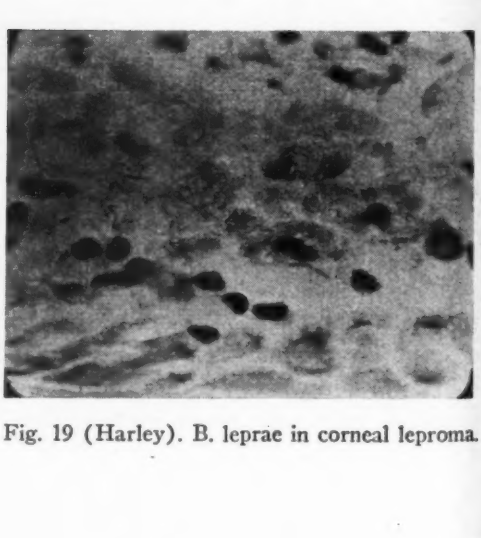

Fig. 19 (Harley). B. leprae in corneal leproma.

and loss of the anterior iris architecture or stroma. In the flat irides a peculiar fine, grayish fibrosis can be seen throughout the interstices of the stroma. Keratitic precipitates and cells are frequently seen under the slitlamp when with ordinary inspection the eye seems quiet.

The most fascinating slitlamp picture of the iris was the tiny lepromas which were seen in over 26 percent of the cases. They occurred always on the background of an old iritis. Typically, they were grayish-yellow, pedunculated, pin-point-sized bodies about the pupillary rim of the iris. However, they occurred deeper in the iris stroma throughout the iris and sometimes in tiny clusters. More rarely they may be seen about the periphery of the iris near the corneoscleral junction.

In two cases larger lepromas were noted. These also stood out from the anterior surface of the iris near the iris angle, and one measured 2.0 mm. in diameter. It developed to this size within one month and then completely regressed within nine months, leaving an atrophic scar in its place on the iris. Incidentally, this patient had a giant leproma of the cornea of his other eye and his brother also had a leproma of the iris which later melted in similar fashion.

It is natural to assume that the ciliary body and at least the anterior portion of the choroid would be involved, although this is perhaps more difficult to demonstrate clinically. It is probably likely, as other writers have suggested, that bacilli come to the ciliary body via the blood stream and diffuse onto the iris or back to the choroid.

Histologically, the sectioned eyes showed infiltration of the ciliary body, iris, and anterior choroid by plasma cells, large mononuclears, and lymphocytes. Lepra cells and bacilli were also demonstrated. The ciliary processes were sometimes found to be adherent to the posterior iris surface, and often atrophy of the ciliary body was easily demonstrable. Cyclitic membranes were present in far-advanced specimens. The pathology of the choroid was always limited to the anterior portion and closely resembled that found in the ciliary body, but perhaps less marked. Leprous involvement of the ciliary body causes destruction of the zonule and subluxation of the lens.

Iridectomy was performed in a few instances to see if this might lessen the attacks of iritis. The iris was found to be exceedingly friable, and pigment readily diffused throughout the collapsed anterior chamber.

Contrary to what one might suspect, secondary glaucoma is not common clinically. Only in two instances was increased intraocular pressure encountered. Even though medication has since been discontinued in these cases, no further tension increase has been noted. This infrequency of glaucoma has been observed by others. It has been stated that it is due to the atrophy and fibrosis of the iris and pectinate ligaments (Kirwan[31]). However, two of the sectioned eyes showed depression of the lamina cribrosa, and a diagnosis of secondary glaucoma was made.

Another interesting observation, perhaps associated with the iris atrophy or possibly due to the direct neural involvement in leprosy, was the lack of response of the leprous iris to atropine. Even in eyes apparently free from synechiae, the poor dilatation obtained from atropine was noteworthy. This fact became especially disconcerting when one tried to get a satisfactory dilatation in cases of iritis.

Sclera

Leprosy of the sclera appears to be nearly always secondary to limbal involve-

ment and reacts to the inflammation through contiguity of structure. The limbal and conjunctival lepromas were invariably accompanied by episcleral injection. Likewise, in some of the conjunctivitides there was persistent episcleral injection after the instillation of adrenalin 1:1,000. However, one would hesitate to consider these as true cases of episcleritis on the basis of the adrenalin test alone. A leproma of the sclera extending from the 11- to the 2-o'clock position occurred in one case. It gradually receded until an atrophic area resulted. At the present time this area has become a bluish staphyloma, and the condition remins stationary. None of the histologic sections showed infiltration into the sclera proper.

Lens and Vitreous

Lens opacities occurred in 29, or approximately 20 percent of cases. In practically every case they developed as a complication of a plastic iritis. One dislocated lens was seen, but this was in a man who had chronic bronchitis with severe paroxysms of coughing. Vitreous opacities were exceedingly uncommon, even in old cases of healed choroiditis. The pathologic change in the lens did not differ from that usually seen in cataracts secondary to inflammation.

Extraocular muscles

One case of divergent strabismus was seen, and this was secondary to a central choroiditis. None of the cases studied revealed any outstanding abnormality of ocular motility. Apparently neural involvement of the third, fourth, and sixth cranial nerves must be exceedingly rare if it occurs at all.

The fundus

The ophthalmoscopic examinations of 50 patients produced entirely negative results. Among the other cases, 8 showed evidence of old healed chorioretinitis—in 5 it occupied a central position and in 3 it occurred in the periphery. None of the choroiditis seen was in any way typical of a specific disease process.

Three fundi exhibited massive colloidal deposits and three others showed small colloidal deposits throughout the periphery. Venous sheathing was noted in one case. A mild hypertensive sclerosis was recorded in seven cases of West Indian Negroes. Hypertensive sclerosis of retinal arterioles is unusual in Panamanians.

Retinal detachment was observed in three cases; one gave a definite history of trauma whereas the other two suggested leprosy as the cause. These latter two eyes have not been obtained for pathologic study as yet, but a cyclitic membrane may have been responsible for the detachments. Two of the sectioned eyes showed detached retinas clearly associated with cyclitic membranes.

Primary optic atrophy was present in one case, but this was a proved case of central-nervous-system syphilis.

Pallor of the optic nerve in the absence of glaucoma was observed in six cases. The pallor was chiefly temporal, and the vision was rarely better than 20/200. These cases were regarded as residual to a previous optic neuritis. None of the sectioned eyes showed any involvement of the optic nerve. Van Poole found 49 cases of optic neuritis in 206 patients, or 23 percent. It was described as transitory, in association with acute reactions or high tissue allergy, but other posterior-segment lesions were rare.

The frequency of involvement of the posterior segment of the eye has been the subject of a considerable difference of opinion. Neve considers the choroid free from attack except at its anterior attach-

ment to the ciliary body. Trantas found punctate lesions with pigmentary proliferation in the peripheral fundi in a large number of the cases that he observed. He found the retinal lesions in the extreme anterior portion at the ora serrata. They are described as round white spots such as are seen in albuminuric retinitis. Digital pressure was necessary to bring out these lesions. Rubert[32] reported changes in 23 percent of his cases. At Palo Seco choroiditis of a nonspecific character was recognized in a little more than 5 percent of patients. Fernandez in 250 cases never found the optic nerve involved and only rarely observed lesions of the retina and choroid. De Vincentiis found the retina and choroid normal as far as the ora serrata in 300 fundi examined. Jeanselme and Morax[33] found changes in a leprous eye in the anterior part of the retina close to the ora and a small nodule lying next to the wall of a terminal arteriole. Gyotoku[34] studied 30 enucleated eyes histologically and concluded that lesions of the fundi were rare. Huizenga[35] and Kirwin examined many leprous eyes and concluded that practically all ocular leprous lesions were anterior.

Prendergast emphasized that a relatively large number of eyes in his cases failed to dilate with atropine sufficiently to allow a satisfactory examination of the periphery. This "atropine resistance" has been noted in a similar large percentage of leprous irides here. However, a subconjunctival injection of atropine, cocaine, and adrenalin frequently induced a prompt dilatation. It was the impression that peripheral synechiae near the base of the iris were often responsible for this poor response to 2-percent topical atropine.

Ophthalmoscopically one fact was outstanding. A comparison of the degree of involvement between the anterior and posterior segments of the eye in leprosy was striking. Leprosy, characteristically, involves the anterior segment of the eye.

Treatment

Medical

As in the general treatment of leprosy, a number of drugs have been applied in ocular leprosy and almost an equal number have been found to be of no genuine usefulness. However, a few therapeutic agents have at least stood the test of time and are indicated in certain leprous ocular disorders. Treatment is difficult to evaluate, since by the very nature of the disease there are periods of remissions when the patient feels quite well and even fancies that his eyes and sight have improved. Ocular leprosy appears to advance in waves—each wave advancing the disease process just a few steps further until vision is eventually lost.

Since the Colony at Palo Seco is run as any other community, medical treatment is not compulsory. The older patients have been seen by so many different physicians and have tried so many different medications that the general attitude is one of hopelessness or at least resignation. It was only over a period of months that an adequate clinic attendance for ocular treatment was instituted. Coupled with the lack of faith in treatment there is difficulty in getting the patients to carry out instructions over a sufficient length of time for anticipated results. The attitude of my patients often struck me as a general apathy toward drugs but an earnest desire to coöperate with me as a friend.

Nearly all the patients have taken, or are taking, chaulmoogra oil or its derivatives. The oil is expressed from the seeds of Taraktogenus kurzii. It is ordinarily given by intramuscular injection,

3 to 10 c.c., or occasionally by mouth in the dosage of 2 drops to 2 c.c., depending on the tolerance of the patient. Mixed ethyl esters of the oil are used regularly, and chaulphosphate (water-soluble chaulmoograte) has been used in a small number of cases for a short time. The beneficial results are apparently transient. Local injections of the ester into nodules about the eyes causes scarification and disappearance of the nodules, such as any other sclerosing solution might perform.

Aniline dyes with and without mercury, serum from cultures, and arsphenamine were without real benefit in leprosy.

Large doses of thiamine chloride injected intramuscularly and given by mouth may be of value in reducing pain in the peripheral neuritis.

In conjunctivitis, especially of the severe purulent type, a 2-percent aqueous solution of mercurochrome appeared to be effective in reducing the discharge and making the patient much more comfortable. There is a general preference for colored medicines among these people and for this reason, perhaps, mercurochrome was used more regularly than clear solutions. A 5-percent sulfathiazol ointment applied night and morning helped to keep the conjunctivitis under control.

It was mentioned previously that the conjunctivitis encountered was probably of nonleprous origin. For this reason it might be expected that any of the reliable medications used for purulent conjunctivitis would be useful.

The leprous keratitides were treated in all stages of development. Five-percent ethylmorphine hydrochloride or 2-percent quinine bisulphate ointment were found to have no effect in improving the cornea or even stabilizing the process. Corneal ulcers, though not commonly seen, respond quickly to the usual treatment. Exposure keratitis due to lagophthalmos was aided by canthoplasty. Xerosis of the cornea and Bitot's spots near the limbus responded readily to vitamin A.

Sol. thyroxin (Squibb) used locally in drops was reported as giving fair results in clearing corneal infiltrates in 4 of Prendergast's 17 cases, although 11 patients reported having better vision. Similar series were tried at our colony. Although 80 percent reported better sight after 49 days, actual improvement by slit-lamp observations could be seen in but half this number. All of the eyes prior to treatment showed a measurable amount of superficial keratitis and one eye of each patient was kept as a control. The visible amount of improvement was small but so far it has been the most encouraging drug used. It is said to act locally by increasing cell metabolism and tissue repair.

Chronic recurrent iritis was one of the most difficult problems at the colony. In many cases the iris had previously been the site of inflammation and was partially bound with synechiae. Even when visible synechiae were not present atropine worked poorly, as previously mentioned. Scopolamine HBr has but little better effect. It was found that intramuscular milk injections, intravenous triple typhoid, and intramuscular diphtheria toxoid were effective in the order named for the recurrent attacks.

These foreign-protein injections also seemed to exert a beneficial effect on the patient as a whole. Contrary to what I first anticipated, the patients began asking for more injections when they first began feeling twinges of pain in their eyes. The foreign protein lessened the duration of the iritis by at least half. High doses of salicylates were of no benefit in chronic iridocyclitis. Mercury and iodides in the form of mixed treatment caused nodules to ulcerate and the medication was soon discontinued.

Lenses were prescribed when requested by the patients, often with surprising improvement in the visual acuity. Glasses are a great vogue among West Indian patients even when the beneficial effects are scarcely sufficient to warrant their purchase. Photophobia is a common complaint as a result of the tropic glare and the ocular pathologic change; ground dark glasses and eye shades have been advised in all instances. These sun glasses provide considerable relief and may even act as a protective mechanism.

Many forms of medical treatment for the eyes seem to work a beneficial psychic effect on the patient during the time that the ocular disease is not actively progressing. However, as soon as there is a subacute recurrence the patient usually stops his treatment, since to his mind it has made him worse.

Faget, Pogge, *et al.*[36] have reported on the use of Promin in leprosy. They found leprous punctate keratitis improved in two cases and observed less frequent attacks of iritis after the use of Promin; improvement in vision occurred in one patient. Promin is being used on a series of patients at Palo Seco at the present time. It would be ideal, of course, to use a drug for leprosy which would inhibit or kill the bacilli. It may prove to be that Promin or another chemotherapeutic compound will act more efficaciously against the disease.

A group of French scientists, who for many years experimented with possible treatments for leprosy, feel that they have at last discovered a probable cure for this disease.[37] This research group, headed by Drs. Grimes and Pierre Boiteau, has just issued a scientific report on the successful treatment of leprosy with the use of a new kind of glucose extracted from "hydracotyle asiatic," a wild plant of the carrot family which grows in Madagascar. As early as 1937 Boiteau and Grimes attempted to use this plant in leprosy, but as the plant's chemical composition was then little known, the extracts that were employed could have proved fatal. Then, in 1939, Dr. Bontemps, who was working in the leprosy research laboratory in Tananarive, discovered a new glucoside which he called "asiaticocide." Less poisonous, "asiaticocide" is insoluble in water, only slightly soluble in alcohol, but can be satisfactorily dissolved in pyridine. After extensive research work Boiteau succeeded in making a solution that could be injected into the blood stream, and further experiments proved highly successful. According to the hypothesis of Boiteau and Grimes, "asiaticocide" acts as a solvent on the waxy part of the microbe. Once this is accomplished the bacillus can be easily destroyed by the human organism itself or by appropriate medication. Remarkable results have been obtained in hospitals. Ocular lesions have been cured in cases wherein the inner chamber of the eye has not been attacked. It has been noted that the nodules and ulcers, which are so characteristic of the disease, yielded readily to the treatment and healed. It is stated that crippled nerve cases require longer treatment, but react favorably to the use of "asiaticocide."

Surgical

Surgery of the leprous eye does not differ from other eye surgery except that one is working with a chronically progressive disease. Therefore, the basic philosophy of the ophthalmic surgeon dealing with leprosy differs to this extent. He is interested in any procedure that will postpone the day of visual loss or may assuage the ocular complaints of his patients, no matter how temporary the relief may be. One cannot afford to

take the attitude of hopelessness and be a good physician among the lepers. Anything but a genuine interest in their plight is quickly detected by these patients, many of whom are unlettered.

Surgery of the lids probably gives the most gratifying results. Secondary to orbicularis paralysis with atony of the lower lids the formation of an ectropion is common. Excessive tearing and macerated lids with exposure keratitis are the usual complications. An ectropion repair, utilizing the Kuhnt-Szymanowski technique, was successfully performed on six lids. All but two have remained in a good state of repair. In these latter two cases the puncta have begun to reëvert due to increasing relaxation of the lower lid. Further removal of skin triangles will reapproximate the puncta. Pinkerton[12] has reported on the successful use of his technique for ectropion repair, which closely parallels the Kuhnt-Szymanowski technique.

Blepharochalasis with a nodule in the most dependent portion has been seen. These are sometimes pendulous to the extent that they interfere with vision. Removal of the redundant skin and resuturing appears to be sufficient.

Chronic dacryocystitis cases are usually surgical problems. Dacryocystectomy is performed when drainage and irrigation are of no avail. A dacryocystorhinostomy is not indicated, owing to the prevalence of infection in the nasal mucous membrane.

Extreme gentleness is necessary in the removal of the tear sac, since the lacrimal bone may be necrotic. In my first tear-sac extirpation I found the tip of my instruments inside the nasal vault despite what I considered gentle manipulation. An external fistula was formed which later was closed by topical application of 50-percent silver nitrate.

Enucleations were performed in five instances; four in recurrently painful blind eyes and the other in a case of a giant leproma of the cornea. The corneal leproma peeled easily at the line of cleavage but the eye was subsequently removed, since it was totally blind. The sockets would easily accommodate a prosthesis. However, by the time patients have reached this stage the loss of their fingers makes manipulation of a prosthesis impossible and they prefer an eye pad or dark glasses.

Pterygia were successfully transplanted in several instances. Yet, as Pinkerton has so well stated, "there is so much to be done for the patient that pterygia are rarely touched unless . . . they are growing to the point of visual disturbance."

Cataract extraction was performed in three cases. In two cases I waited a year in an endeavor to lessen the chronic iritis as evidenced by posterior synechiae and keratitic precipitates. The iridectomy was done corresponding to the clearest part of the cornea. There was visual improvement in each instance, although far below what one might anticipate from an uncomplicated cataract. A broad iridectomy with attempted release of synechiae was carried out in two other cases. Discissions were done on two patients who had after cataract.

It is of interest to know that the leprous eye withstands surgery well despite a recognizable amount of chronic inflammation. In fact, of the intraocular surgery performed it is believed that most of the eyes now appear to have less inflammation than prior to surgery. It has been previously observed and mentioned that leprous eyes seem peculiarly immune to the ordinary organisms. Questionable aseptic technique often put this to a severe test. There were no postoperative infections in any case.

It was also observed that despite all the blind and phthisical eyes that were seen very few patients complained. Diabolical as it may seem, as long as any sight persisted a chronic recurrent inflammation attacked and reattacked their eyes. Often the phthisical eyes became less painful and less inflamed after all the damage had been done.

It is to be remembered that ocular leprosy has the same course as the general disease, so that palliative measures are the chief resort, at our existing stage of information.

Summary

1. The effect of leprosy on the eye has been studied in 150 cases in Panama.

2. Seventy percent of the patients were natives of Panama, the remainder came predominantly from the bounding countries and the West Indian Islands.

3. Ninety percent of the patients of the leprosarium were found to have ocular involvement.

4. Impaired vision is common in leprosy. Thirteen percent were totally blind and an additional 41 percent had vision reduced to 20/200 or less.

5. The anterior segment of the eye is by far more frequently involved than is the posterior segment.

6. Superficial punctate keratitis or pinpoint lepromata of the irides are so typical as to be diagnostic of ocular leprosy.

7. Glaucoma is not common.

8. Absolute corneal anesthesia is rare, but relative loss of corneal sensitivity does occur.

9. Prophylaxis for leprous eyes through protection with dark glasses or goggles is indicated. The factor of protection has been underemphasized in the past.

10. Therapy is largely confined to palliative measures.

11. Solution thyroxin used topically may be of aid in helping to clear corneal infiltrates.

12. The leper withstands surgery of the eye better than one might suspect. Surgery of the lids produces gratifying results.

Gorgas Hospital.

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SUPERFICIAL PIGMENTATION OF THE CORNEA

R. R. BLONDIS, CAPT. (MC), A.U.S.

Pigmentation of the superficial layers of the cornea has not been described frequently in scientific literature and for this reason, perhaps, has been considered rare, whereas pigmentation elsewhere in the body surface has been accepted as a common occurrence. The following observations had their origin during the study of the clinical pathology resulting from the action of chemical-warfare agents on the eyes and are presented for their medical interest and to add to the fund of general knowledge. It is hoped that complete correlation of this subject with that of pigmentation of other epithelial membranes will thus be aided.

Pigmentation of the superficial layers of the cornea has been described in normal eyes in senility, congenital melanosis, after severe infections such as trachoma and keratitis eczematosa, and in avitaminosis A. It was previously our opinion, based on the study of reports of extensive series of cases, that pigmented lines in the superficial cornea were rare.[1,2] Frequent appearance of such pigmentation following chemical injury stimulated our search in other conditions and resulted in observing it in several unrelated pathologic states.

The morphologic characteristics of the pigmentation seen have been those of Stähli-Hudson lines, Fleischer rings (as seen in keratoconus), crescents, oblique lines, and amorphous pigment deposits (figs. 1, 2, 3, 4).

The first of these needs no explanation; it was seen in three types described by Vogt (green-brown, ochre-yellow, and colorless). Since these so-called types have been seen to develop from the colorless to the most colorful in the same lesion, without change in shape, we feel that they are the results of the same abnormality and represent merely stages in development.

The Fleischer rings observed have all been incomplete and otherwise exactly as described as occurring in keratoconus.

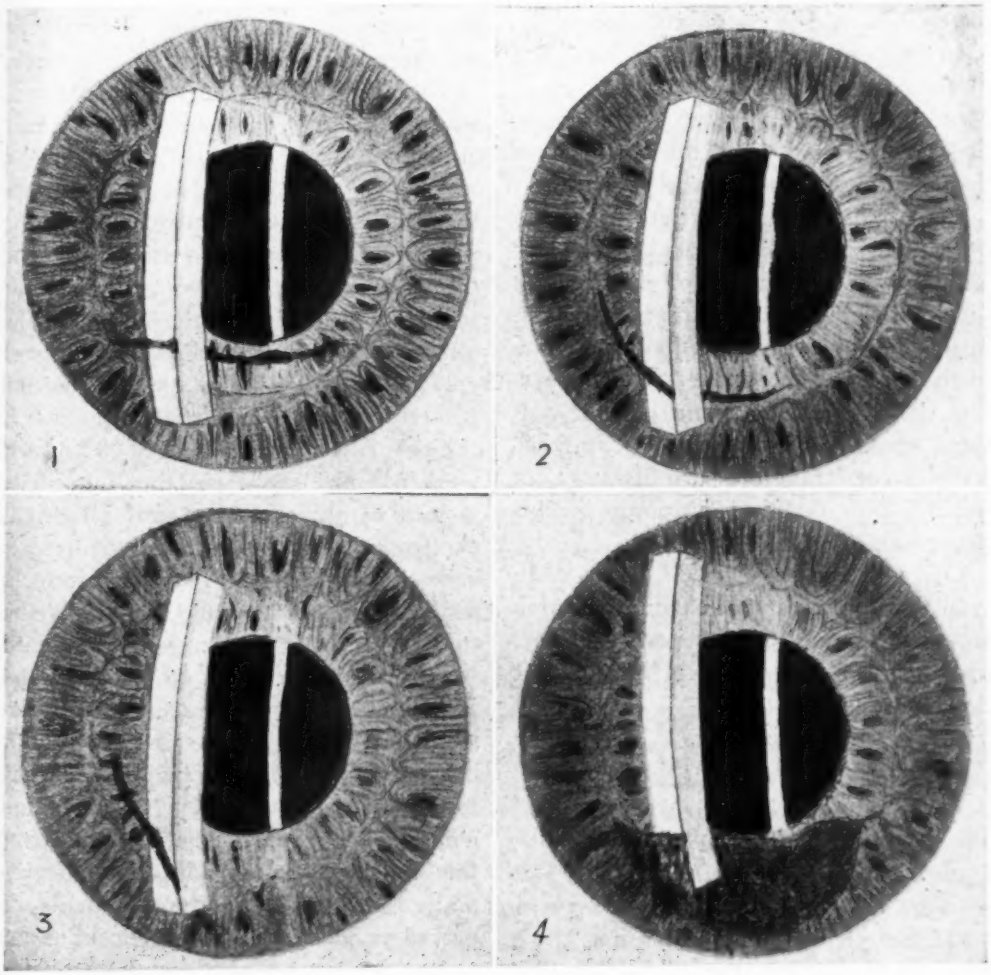
A search through the available literature revealed no exact reference to the crescents of pigment. These occurred near the inferior corneal limbus but were separated from it by two or three milli-

meters of normal cornea. The superior borders of these pigmented areas were almost horizontal, and the crescents occupied the portion from the lower third to the lowest sixth of the corneas. Individual pigment clusters were contained within the epithelium to a very slight extent and to a far greater one within Bowman's membrane. The surface of the involved cornea was entirely regular. Pillat[3] has described pigmented areas so placed and shaped as to resemble the pigmented crescents herein depicted. He considered these to be melanomata.

The oblique lines have all been identical with Stähli-Hudson lines except that they ran in a vertically oblique direction.

Amorphous pigment deposit is a term used here to describe a group of pigment clusters without discrete boundaries and occurring in the Bowman zone.

In these types of superficial pigmentation the color of the pigment varied from light yellow through green to dark brown.



Figs. 1, 2, 3, 4 (Blondis). Semidiagrammatic drawings of pigmented corneas. Fig. 1, Stähli-Hudson line intercepted by slitlamp beam. Fig. 2, Fleischer ring intercepted by slitlamp beam. Fig. 3, oblique line intercepted by slitlamp beam. Fig. 4, crescent intercepted by slitlamp beam.

All shades were seen, varying with the severity of the pathologic process, its duration, and the individual complexion. In all cases, all other factors remaining the same, in the Negro and the dark-complexioned races the pigmentation was of darker hue and more bountiful. Whenever there was a concomitant pigmentation of the skin the corneal pigmentation (if present) was in direct ratio. Except in the cases of amorphous deposits the reaction was reversible and the pigmentation disappeared when the eye had completely returned to its normal state.

In this study superficial pigmentation of the cornea was found in five types of corneal pathologic change. There can be little doubt that these do not exhaust the conditions wherein it can occur.

Four hundred and fifty-three (453) individuals whose eyes had been burned with the vapor or liquid of mustard gas (dichloroethylsulfide) have been examined. These cases revealed pigmentation of the superficial cornea in 127, or 28 percent. In other chemical burns of the eyes the corneas were not routinely searched for pigment. Therefore such cases are not utilized for statistical purposes in this paper.

Of approximately 3,600 other individuals whose eyes were examined, search for pigmentation of the superficial layers of the cornea revealed it in 71 cases, or 2 percent.

Case reports

The following reports are typical of the cases in which the pigmentation described was observed.

Case 1. A white man, aged 62 years, was subjected to the explosion of a mustard shell while unmasked. His left eye was severely burned and his right only slightly. After 12 days, examination of the cornea of the right eye with a microscope showed a typical Stähli-Hudson line. This was colorless; three days later it was ochre-yellow; one week later it was greenish-brown. Three weeks after the injury the line had completely disappeared, and there was no sign of the injury the eye had suffered. The left eye at no time showed corneal pigmentation. Despite the severity of the burn of this eye no vascularization of the cornea developed and no iris changes or keratitic precipitates were seen. The pathologic change was essentially an infiltration of the cornea below Bowman's membrane which resulted in a "snow-flake" stroma.

Case 2. A white man, aged 26 years, was subjected to the same explosion and suffered a severe burn of the left eye and a mild one of the right. The findings were the same as in case 1 except that the pigmented line ran in a vertically oblique direction in several widespread areas of the exposed portion of the cornea of the mildly injured eye. The severely injured eye followed the same pattern as the severely injured eye described in case 1.

Case 3. A Negress, aged 32 years, worked, unmasked, in the immediate vicinity of a mustard-gas spill. Her right eye was moderately burned and her left severely. Eight days after the injury an incomplete Fleischer ring was visible in the cornea of the right eye. This remained for three months. All other signs and symptoms resulting from the injury disappeared about two weeks earlier. For the first three months following the injury to her severely burned eye there was no evidence of corneal pigmentation. After this time she developed pannus degenerativus of this cornea and with it appeared an influx of brown pigment as far as the vertex of that membrane. This coloration was amorphous, patchy, and followed the approximate course of the invading blood vessel. At this date (six

months after the injury) the vascularization and the pigmentation are still present.

Case 4. A Negro, aged 42 years, was exposed on two successive days to the vapor of mustard gas. On the third day he developed a typical keratoconjunctivitis[4] of both eyes. Two days later, as the signs and symptoms receded, there was noted an area of greenish-brown pigment, crescent shaped, occupying the lower third of the cornea. Examination with the microscope revealed pigment following slightly irregular lines, densely packed, separated from the limbus by an unpigmented zone about 2 mm. wide. The pigment was limited to Bowman's membrane. About eight days after the injury, although the signs and symptoms had almost disappeared, the upper border of the pigmented crescent had become demarcated into a distinct line resembling a Stähl-Hudson line but continuous with the crescent-shaped area of pigment below it. Seven weeks after the injury and six weeks after all other signs and symptoms had disappeared there was no sign of corneal pigmentation.

Case 5. A Negress, aged 37 years, suffered a burn of the cornea of the left eye from white phosphorus. This resulted in an indolent ulcer at the site of the injury. About three weeks after the burn, the injury had been converted into an epithelized, nonstaining, depressed facet, and at this time its base became infiltrated with a yellowish-brown color. This pigmentation was limited to the burned area in Bowman's zone and increased in intensity for one week after it first appeared. Eight weeks later the depressed facet had been filled in from below and was nebulous. At this time the pigmentation was sufficiently diminished in amount to make it barely visible with the microscope.

Case 6. A man, Mexican-born, aged 28 years, had bilateral vascularized pterygia that encroached on his corneas for approximately 4 mm. He was unaware of their presence. Both corneas showed typical Stähli-Hudson lines.

Case 7. A white child, aged 6 years, was first seen with a solitary phlyctenule of the cornea of the left eye. There was no pigmentation of the superficial cornea. About two weeks later there were multiple phlyctenules and encroaching vascular fasciculi. At this time one of the therapeutic agents used was a 0.1-percent solution of epinephrine hydrochloride.[5] Five weeks after the onset of the disease the entire cornea was traversed by superficial blood vessels. At this time there first appeared a colorless dehiscence corresponding to a Stähli-Hudson line in location and form. Within two days this line was colored greenish-brown. The vascularization of the cornea and the pigmented line are still present although it is approximately four months after the onset of the illness.

Case 8. A white man, aged 28 years, was first seen with severe, acute iridocyclitis, hyphema, hypopyon, and secondary glaucoma of the right eye. The cause of the inflammation was undetermined. He was treated with the usual local medication and typhoid vaccine intravenously. Two weeks after his illness started the intraocular pressure was within normal limits, there was no blood nor other cells in the anterior chamber and all signs of inflammation were minimal. At this time a typical Stähli-Hudson line was first seen. It was ochre-yellow in color and remained visible with the microscope for five weeks. All other signs of the inflammation had disappeared one week before this except two minute posterior iris synechiae.

Discussion

Most frequently, this corneal discoloration occurred in eyes which were burned with mustard-gas liquid or vapor. It was a frequent finding and disappeared during the stage of healing, which may be prolonged many months if the injury has been caused by the liquid.[6]

It has been a common observation that long contact with the vapor of this vesicant, even though insufficient to cause injury, has resulted in progressive pigmentation of the exposed skin; but it has not been observed in either the conjunctiva or the cornea. This pigmentation is considered to be a response to chemical irritation, a phenomenon long ago observed.[7]

It is interesting to note that when the corneal burn from mustard gas has been severe this pigmentation has not been observed except when the injury to the cornea resulted in vascularization of that membrane. Redslob[8] found that when the achromogenic cornea is vascularized it develops the potentialities necessary for the elaboration of pigment. When the injury to the cornea penetrated beneath Bowman's membrane no pigmentation of the cornea was observed. When the corneal injury had been deep enough to cause inflammation of the iris with keratitic precipitates these became pigmented quickly.

Pigmentation of the superficial cornea in cases of abrasion in the absence of a foreign body occurred in this series. Here the pigment lay within Bowman's zone in the area of injury and occurred only during the stage of healing. Infection did not need to be present to induce this phenomenon. Staining with 1-percent cresyl-blue solution revealed that these corneas had dilated lymph spaces. The mechanism here was probably the same as that in chemical injury of the cornea. Here too the injury causing a pigment response did not extend beneath Bowman's membrane.

As has already been pointed out, yellowish-brown pigmentation of the superficial layers of the cornea in keratitis eczematosa[9] has been observed during this study. The pigment appeared shortly after the vascularization of the cornea, was superficial (within Bowman's zone), yellow to brown in color, and disappeared with the disease. In this condition the pigment existed as Stähli-Hudson lines and also within the maculas resulting from ulcerated phlyctenules to which vascular fasciculi had extended. It is noteworthy that one such case was treated with a solution containing 0.1-percent epinephrine hydrochloride over a period of several months (case 7). Loewenstein[5] reported that the long-continued use of adrenalin as drops can give rise to pigmented nodules on the conjunctiva. Further, he produced this experimentally.

The nature of the pigment occurring in the cornea has been the subject of some speculation but of little investigation. The likelihood that this pigment is melanin is supported by the similarity between the crescents of pigment herein described and the accumulations of pigment reported by Pillat and by him considered to be melanomata. In addition, some of the pigment seems to be identical in appearance with that described by Meesmann[10] within the cells of the corneal epithelium in Addison's disease. Further, the greater amount of pigmentation in the superficial cornea in Negroes than in whites with the same or similar pathologic conditions speaks in favor of melanin.

To this fact, should be added the relationship of the corneal pigmentation to that occurring in the skin. In mustard-gas keratitis, there occur several of the types of superficial pigmentation of the cornea herein described and not infrequently a

pigmentation of the skin that is clinically indistinguishable from melanosis. When it is recalled that the conjunctiva is but a modified skin and the corneal epithelium merely an especially adapted epithelial layer of that membrane, this concomitance takes on special significance. No report in the literature has shown the presence of melanin or its precursors in the urine of individuals suffering from such exposure. We have attempted to find such pigment in the urine and have been unsuccessful.

Duke-Elder[11] describes the migration of chromatophores from the stroma of the uvea into the ciliary muscle and the inner layers of the sclera, whence they sometimes travel along the perivascular channels to appear subconjunctivally and within the loose episcleral tissue associated with vessels and nerves. The close relationship between the conjunctiva and the corneal epithelium has already been mentioned.

Redslob[8] found that some of the deeper cells of the conjunctiva covering the caruncle were potential melanoblasts which became deeply pigmented on oxidation, and further demonstrated the presence of potential melanoblasts in the region of the limbus. In addition, it is known that the caruncle is frequently pigmented during Addison's disease. Therefore, it seems quite likely that the limbus forms a barrier to the passage of the melanin from the conjunctiva to the corneal epithelium despite the close relationship between them. These melanoblasts within the deeper layers of the limbus contain a colorless substance that is converted into melanin in the presence of the oxidizing ferment dioxyphenylalanine (dopa). The barrier at the limbus may be physiologic, physical, or chemical, and during the pathologic process may be neutralized to permit the migration of these cells into the corneal epithelium. There may well be a chemotaxis that stimulates migration of cells along the corneal lymph channels, which have been demonstrated with intravital staining to be widely dilated following chemical irritation of that membrane.

Some investigators have stated that the pigment is derived from the blood, and, indeed, Moncrieff[1] has shown in one reported case that it was hemosiderin. There is little evidence to support this idea in the cases here reported. However, the actual demonstration of hemosiderin by Moncrieff within the cornea must be accepted as more accurate than mere observation. According to her conception the blood pigment diffuses down from the upper limbus through the intercellular spaces of the corneal epithelium.

Stähli[12] postulated that the pigment was derived from the alkali-hematin present in the tear fluid and the pooling of that fluid in the inferior cul-de-sac caused the imbibition of the pigment into the corneal epithelium. There is no absolute evidence to support this hypothesis.

All investigators are in agreement concerning the development of the Stähli-Hudson line. There occurs a tension of Bowman's membrane that is most marked at the meeting point of the upper and lower lids during the winking reflex. This results in either a degeneration or tear in that membrane along that line, and is intensified by the mechanical action of the lids. The dehiscence thus formed is demonstrable with the slitlamp and corneal microscope, when using a 1-percent solution of cresyl-blue stain in normal eyes of some middle-aged and elderly individuals. It is this dehiscence that is responsible for the colorless type of Stähli-Hudson line described by Vogt. If the pigment described is melanin it is deposited here through the migration of

melanoblasts along the intracorneal lymphatics. At this line it is assumed that the colorless pigment-bearing cells are converted into colored, pigment-bearing cells and become temporarily fixed. It is more difficult to comprehend that the diffusion of hemosiderin to this line is possible in the absence of any trace of its path, although Moncrieff found that histologically actual pigmentation was much more extensive than that seen clinically.

The formation of the Fleischer rings is similar. The lesion lies in Bowman's membrane and the pigment therein occurs in the same manner as in the Stähli-Hudson line. The only difference is in the location of the original stress or trauma to Bowman's membrane and this depends on the area of maximum injury to the cornea.

The oblique lines within the cornea that occur also in Bowman's zone are undoubtedly produced in like manner and their position and direction are results of trauma in varying areas and directions.

The explanation for the formation of the crescent of pigment seems to agree with the hypothesis of Stähli who considered the pigment to be an iron derivative from the alkali-hematin of the tears. Certainly the pooling of the tears in the inferior cul-de-sac could produce such a formation of pigment, provided that the pigment could be imbibed by the corneal epithelium. This does not explain why the greatest amount of the pigment is in Bowman's zone and not within the epithelial cells themselves. It seems more likely that this area is merely a dense arrangement of lines produced in the manner suggested above and that the pigmentation occurs in a like manner.

Summary and Conclusions

1. Pigmented lines in the superficial layers of the cornea are not rare in our experience. They were seen in 28 percent of 453 individuals whose eyes were burned with mustard gas and in 2 percent of 3,600 other cases in such conditions as white-phosphorus burns, pterygia, eczematous keratitis, and iridocyclitis.

2. Eight case reports are presented which represent the abnormalities in which this pigmentation has been observed and the various morphologic characteristics of the pigment.

3. Stähli-Hudson lines, Fleischer rings, oblique lines, and pigmented crescents are the result of pigmentation of dehiscences in Bowman's membrane and represent merely the same type of injury in different locations within this membrane.

4. Observation of the cases reported here favors the concept that this pigment is melanin, although histologic and chemical studies in a single case demonstrated that the pigment in that case was hemosiderin. Conclusive evidence of the character of the pigment is not yet available.

5. If a corneal burn extends deeper than Bowman's membrane, no pigmentation occurs unless the superficial cornea becomes vascularized.

6. In the presence of the abnormalities already described, the melanin content of the conjunctiva at the limbus is increased, but this pigment does not invade the cornea unless damage has been done to that membrane. This suggests that a barrier to the cornea exists at the limbus which is destroyed when that membrane is injured.

7. Most observers agree that the pigment reaches the superficial layers of the limbus and the most likely pathways are the lymph spaces in the cornea, which can be demonstrated under certain conditions to be widely dilated.

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GLIOMA OF THE OPTIC NERVE*

MAX MANNHEIMER, M.D.

Jackson Heights, New York

In a review of the whole literature in 1912, Hudson[1] mentions not more than 182 cases of glioma of the optic nerve. Katzin[2] recently reported a case of glioma of the optic nerve with discussion of the occurrence, symptomatology, course, and pathology, and pointed out that this lesion had been described not more than 300 times in the literature up to the present. This rare occurrence seems to be reason enough to add another case of such a neoplasm that has just come under observation.

Case report

E. F., a colored girl aged eight years, came to my office on March 3, 1945. Her father stated that the right eye had been swollen for six weeks, the swelling gradually increasing. There had never been any inflammation of the eye; nor was there a history of an injury. The child had not complained of pain at any time. No convulsions or other signs had been noticed. An optician or optometrist had provided her with glasses one month ago.

The child had never been seriously ill.

The general aspect of the patient was good. She was well nourished and seemed to be healthy. Her answers revealed normal mental qualities.

Both eyes were white, without irritation. There was marked proptosis of the right eye, with some restriction of the movements to the extreme right and left. Tension was good in both eyes.

Right eye: There was a definitely increased resistance to backward pressure of the eyeball. No masses could be felt around the globe. The pupil was fixed to light, dilated, and reacted well consensually. Vision was nil.

The lower portion of the disc was swollen, covered with a mass of inter-

* From the Ophthalmological Service of Dr. R. K. Lambert, The Mount Sinai Hospital.

twining small and large blood vessels, partly newly formed. This mass extended out into the vitreous to a height of about 6D. As did also the adjacent lower part of the retina, which was grayish and showed dilated and tortuous vessels. There was no detachment of the retina.

The *left eye* was normal in all respects, vision being 20/20 with a +2.5D. cyl. ax. 90° lens.

The tentative diagnosis was: Tumor of the optic nerve.

On the basis of diagnosis the patient was referred to the Mount Sinai Hospital, where the ocular findings were completed by exophthalmometry. The readings were: R.E. 22, L.E. 16 at 98 mm. The width of the papebral fissure was: right, 10 mm.; left, 7 mm.

The field of the left eye showed a slight limitation medially and in the lower field.

Transillumination could not be effected because of poor coöperation.

The general medical examination revealed no pathologic findings. Wassermann reaction was negative. There were no signs of tuberculosis. An X-ray study of the skull showed a considerable enlargement of the right optic foramen, which was approximately twice the size of the left (fig. 1). There were no demonstrable abnormalities of the orbit or sella turcica. X-ray studies of the abdomen and of the long bones revealed no evidence of metastases. An electroencephalogram was normal.

The differential diagnosis between neoplasm of the orbit and tumor of the optic nerve was not difficult, for the main symptoms suggesting the latter were present; namely, nonpulsating, slowly progressive proptosis straight forward, light limitations of movements, early visual failure, papilledema, and, perhaps as the most important symptom, enlargement of the optic canal.

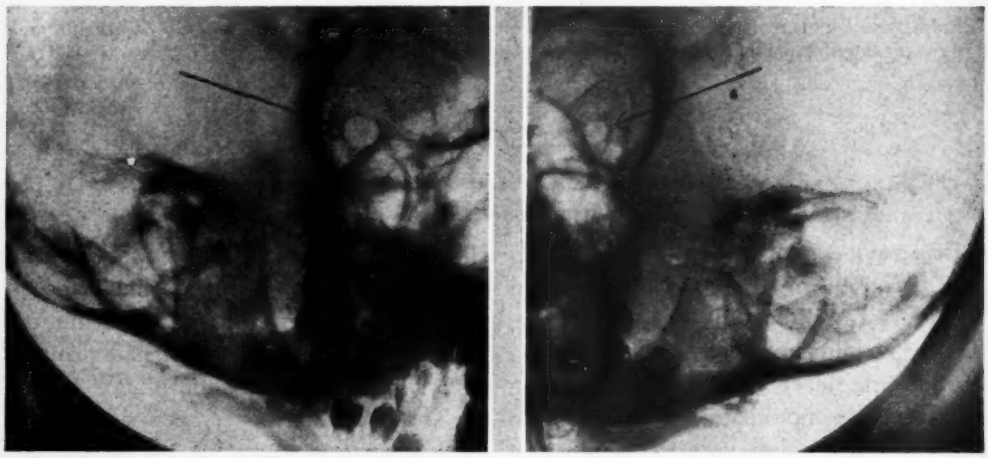

Fig. 1. (Mannheimer). Roentgenogram of the skull showing the enlargement of the right optic foramen.

Since the intracranial part of the optic nerve was unquestionably involved, Dr. Ira Cohen was consulted, who suggested intracranial section of the nerve prior to enucleation. He proceeded as advised by performing a craniotomy on March 30th.

Operation. On the right side, a Frazier type bone flap was turned down. Before opening the dura through a nick in it, a brain needle was passed into the anterior horn of the right lateral ventricle. This allowed the escape of an estimated 10 c.c.

of spinal fluid. The dura was then opened by an incision just above the bone margin along the temporal and frontal portions. The frontal lobe was elevated. The olfactory nerve was identified and freed from this attachment. Further retraction exposed the right optic nerve. For a little over one half of its distance from the

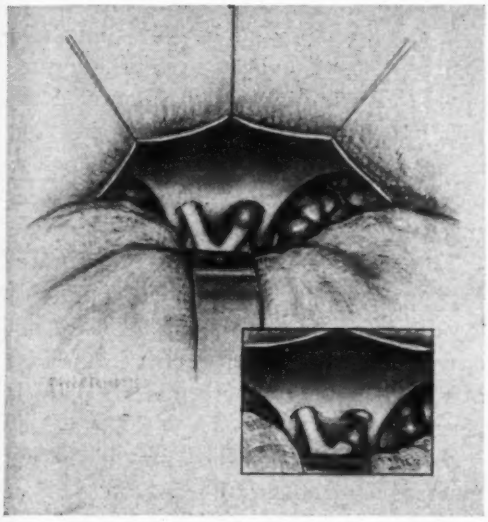

Fig. 2. (Mannheimer). Operative field sketch showing the tumor of the right optic nerve before and after resection.

optic foramen and the chiasm, it was very much swollen, probably three to four times the normal diameter. It was also somewhat knobby (see figure 2, drawn during the operation by Alfred Feinberg).

With the trigeminal sharp hook, the nerve was divided close to the chiasm. Then, with the cutting loop, it was removed in two sections, flush with the optic foramen. There was a little troublesome bleeding from the cut in the nerve, which was coagulated. It is judged that not more than 1 mm. of the nerve was left proximate to the chiasm, and this appeared normal.

Bleeding having been completely controlled, the dura was tightly closed, a Penrose drain was let out from the extradural space through a stab wound posteriorly, the flap was replaced, the anterior inferior burr hole was filled with a mixture of bone dust and bone wax, and the scalp was replaced and sutured with two layers of silk.

The child stood the operation very well. Nevertheless, a transfusion was given, beginning at about the middle of the operation.

The postoperative course was uneventful.

The microscopic picture of the resected nerve was described by Dr. Globus as follows:

Section stained with hematoxylin and eosin shows the tissue to be for the most part broken up into small lobules or compartments, but with fairly well-developed connective-tissue trabeculae. Within each of these compartments, there are many cells recognizable mainly by the incorporated nuclei. The latter are variable in size and outline, the majority, however, being oval and fairly rich in chromatin. The nuclei are supported by a syncytium of cytoplasm material which in places is highly vacuolated and in other parts indicates the reticular nature of the cells. In all probability these cells are glial in character. In some compartments the nuclei are much denser than in others, and in some are exceedingly few. Diagnosis: Glioma of the optic nerve (Schwannoma).

On May 1st a second operation on the child took place. Dr. Lambert performed an enucleation with extirpation of the optic nerve. Its isolation from the surrounding tissues within the narrow orbit was tedious. However, working along the nerve in a proximal direction, he was able to resect the entire nerve. It was cystlike, thickened, the diameter of the most enlarged site being approximately 15 mm. The tumor was entirely confined to the optic nerve, with no spreading to the orbital tissues (fig. 3).

Fig. 3. (Mannheimer). Enucleated globe with resected optic nerve.

The postoperative course of the second operation was uneventful. The child is at present (six weeks later) in good general health. Her left eye is normal, especially the fundus, and she has the same vision as when seen first.

The prognosis of this case is favorable. As gliomas do not metastasize and do not perforate the sheaths of the nerve, it may be assumed that the child will remain well. The decisive factor is the involvement of the chiasm, but an operation is not feasible. With further infiltration of the chiasm there will follow blindness of the other eye, sooner or later, and from pressure on the centers of the diencephalon serious disturbances of the vegetative system will ensue and finally death. Whether X-ray therapy can be of lasting benefit, is doubtful. Duke-Elder goes so far as to call roentgen therapy "of little significant value." On the other hand it is well known that gliomas of the optic nerve have a slow growth; von Hippel[3] mentions a patient under his observation, who was absolutely well after an incomplete extirpation 20 years previously.

Discussion

The case herein presented, so far as symptomatology, therapy, and pathology are concerned, is to be regarded as rather typical. With reference to the differential diagnosis it has been pointed out that all symptoms of an optic-nerve growth were present. They are similar to those of an orbital tumor, the three classical symptoms of which were established by von Graefe[4] as early as in 1864; namely, proptosis, disturbance of the motility of the globe, and visual deterioration. The displacement of the globe in tumors of the nerve is usually directly forward or approximately so, showing slow progress. The motility of the globe is less impaired than might be expected from the proptosis. This is different in tumors of the sheaths, when the orbital muscles and nerves become infiltrated; then ocular movements become considerably restricted.

The visual acuity usually deteriorates early and rapidly. For this reason diplopia by displacement of the globe does not occur, contrary to what occurs in the case of orbital tumors, where this symptom is very common.

The tendency of the growth of the tumor is directed back toward the brain; it may, as Duke-Elder puts it, "cause a hypermetropic refraction by pressure upon the posterior pole of the eye. More commonly the effects of obstruction of the circulation are seen—papilledema, and eventually secondary atrophy are relatively common." In my case there was both a hyperopia of 6D. and a partial papilledema. There was no atrophy of the disc; this agrees with the fact that in most cases the degree of visual defect is out of all proportion to the ophthalmoscopic signs. One of the most important changes caused by the proximal growth of the tumor—namely, the enlargement of the optic foramen—was present. Thus, an involvement of the intracranial part of the nerve by the neoplasm was out of the question. As symptoms of extension into the chiasm and into the brain were absent, the therapeutic procedure was a first operation—resection of the intracranial part

of the affected nerve—and a second operation—the extirpation of the intraorbital portion. The ophthalmoscopic findings were such as led to the assumption that the posterior pole of the globe was involved or at least its immediate vicinity, so that the eyeball had to be sacrificed. Since this was not the case a resection of the orbital part of the nerve could have been performed by means of the Kroenlein operation, with preservation of the globe, done for the first time in a case of optic-nerve tumor by Braunschweig[5] in 1893, or by opening the orbit from the conjunctiva with temporary tenotomy of the recti internus and superior.

The anatomic nature of tumors of the optic nerve remained controversial for a long time with much confusion as to the terminology. Since the classical papers of Hudson in 1912 and of Verhoeff[6] in 1922 the anatomic picture has been clarified. These investigators pointed out that "the essential feature in the production of these tumors is an overgrowth of glial tissue" and that "gliomas are the only primary intraneural tumors of the optic nerve that have been observed." They differ from each other only quantitatively, depending on the presence of various glial elements in different proportions and arrangements. These true gliomas are related to those occurring in the brain and, this should particularly be stressed, have no relation to the common malignant tumors of the retina popularly called "glioma."

As has been mentioned, all optic-nerve tumors, whether they originate from the nerve proper or from its sheaths, are rare, the gliomas being the most common. Reviewing large series of treated patients, Collins and Marshall, as also Verhoeff, came to a ratio of tumors of about 1:176,000 (Davis[7]). With regard to the age of the patients, most gliomas were found in children under five years of age. Tumors of the nerve sheaths—endotheliomas of Hudson—occur later, most of them after the age of 30. Most observers agree that the female is more frequently affected; Lundberg,[8] however, could not find this difference in his cases.

The vast majority of the gliomas arise from the intraorbital portion of the optic nerve. Their growth is fairly characteristic. It is almost invariably slow, although temporary periods of rapid growth have been reported. They advance by direct extension along the intraneural portion of the nerve and, as has been mentioned do not penetrate the sheaths, so that as a rule a diffuse and uniform hypertrophic swelling, sometimes of a spindle-shaped appearance, is produced.

The glial tumor starts with an abnormal proliferation of the normal adult type of neuroglia (Davis). The neoplastic tissue permeates the intraseptal spaces, with occasional invasion of the septa. They usually are enormously thickened, made up of collagenous fibers. This collagenous hyperplasia is regarded as reactive in nature and secondary to the gliomatous process in the nerve. This is particularly obvious when a glioma occurs in general neurofibromatosis or von Recklinghausen's disease. By the growth of the glial tissue the nerve fibers are spread apart, stretched, and compressed, so that they become demyelinized at an early stage, which means loss of vision. The intermingling of secondarily proliferated mesothelial cells of the arachnoid with the neuroglia cells produces a complex histologic structure, the precise nature of which is difficult to interpret. The neoplastic glial cells are uni- or bipolar spongioblasts in type, are long and spindleshaped with oval nuclei and processes at each end. From an embryologic point of view it will be understood that

these cells are identical with the characteristic cells of this type of tumor that is found in the brain.

Summary

A somewhat typical case of glioma of the optic nerve has been presented with discussion of the diagnosis, operative treatment, and biopsy. The favorable prognosis has been stressed after extirpation of the neoplasm *in toto*. Two operations at different times proved to be the therapy of choice.

35-30 Eighty-first Street.

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THE RELATIONSHIP BETWEEN LIGHT ADAPTATION AND DARK ADAPTATION AND ITS SIGNIFICANCE FOR APPRAISAL OF THE GLARE EFFECT OF DIFFERENT ILLUMINANTS*

ERNST SIMONSON, M.D., SAMUEL S. BLANKSTEIN, M.D., AND EBEN J. CAREY, M.D.

A precise knowledge of the characteristics of adaptation of the eye to light is of importance for several reasons other than that such a fundamental process should be as clearly understood as possible. It will be demonstrated in this communication that serious errors will result in the determination of dark adaptation if account is not taken of the initial adaptation to light. Accurate determinations and the understanding of the effects of glare are not possible without a knowledge of the adaptation to light.

Data on light and dark adaptation on 10 individuals will be presented. Particular emphasis has been placed on the relationship between the rates of light and dark adaptation, the relationship between the dark-adaptation time and the initial light-adaptation threshold, the relationship between brightness and length of exposure to the rate of light and dark adaptation, both daily and interindividual variation, and the effect of spectral distribution.

In contrast to the great number of publications on dark adaptation which have been published during recent years, the problem of light adaptation studied by determination of brightness thresholds has attracted considerably less attention. Several publications have presented data on the influence of brightness level on light adaptation,[1-4] but we know of only one paper[5] wherein the speed of light adapta-

* From the Laboratory of Physiological Hygiene, University of Minnesota, Minneapolis, and Marquette University, Medical School, Milwaukee.

tion has been investigated by varying the duration of light exposure at a constant brightness. However, the time intervals used were too long to determine details of the course of light adaptation, especially in the early phases. These data have established that, in general, light and dark adaptation follow opposite trends. With increasing exposure time or higher brightness, light adaptation proceeds faster and dark adaptation more slowly. For this reason, light and dark adaptation might be looked upon as corresponding catabolic and anabolic processes expressed in terms of concentration of photosensitive material, as is the case in Hecht's formula.[4] While there is no doubt of the opposite trends of light and dark adaptation, their mutual relationship has not yet been thoroughly studied. Some discrepancies between light adaptation and dark adaptation are apparent in the material of Hecht *et al.*[1] and of Müller[5] as well as in our own investigations on the light penetration through the eyelids.[6]

Method

Due to the numerous variations of time intervals and brightnesses in our experiments, resulting in up to 40 exposures in one single testing series, Blanchard's[3] method for determining the instantaneous thresholds after light exposure was not applicable. Instead, we used an approximate method, measuring the threshold about five seconds after the light exposure in successive experiments with increasing light-exposure duration; this we define as the relative light-adaptation threshold. Thus, we obtained a curve of threshold values somewhat below the instantaneous threshold but closely related to it. Variation of $\pm$ 1 second in the time of the first reading produced only minor differences of the relative light-adaption threshold, hardly exceeding the experimental error ($\pm$ 5 percent).

After the first reading, which is an index of light adaptation, the progressive dark adaptation was measured until the value of 0.05 millifoot candles (M.F.C.) was reached. This value includes full cone adaptation and the first (rapid) segment of rod adaptation after longer exposure times or higher brightness. After short exposure time, the dark adaptation is so rapid that cone and rod adaption are not clearly separated.

Newton's instrument was used, in which the brightness of the test patch (of one-third degree, five degrees above the small red fixation point), is changed by varying the angle of a light beam illuminating the test patch. Thus, the color of the test patch does not change at different brightness levels. In order to investigate the effect of spectral distribution, ordinary frosted incandescent lamps (A) were compared with a new illuminant (B) with reduced radiation at both ends of the visual spectrum. More detailed information about the spectral distribution of this illuminant (Verd-A-Ray) is given in former papers.[7, 8] On each experimental day, both the illuminants—A (ordinary frosted lamps) and B (Verd-A-Ray lamps)—were compared at the same brightness level. For light exposure, the subject viewed, from a distance of six inches for lamp A, a frosted glass plate placed in front of a box and illuminated from behind by a centrally fixed lamp. The different levels of illumination were obtained by using different bulbs (25, 60, 100, and 200 watts), corresponding to 125, 200, 620, and 1,050 F.C. at the level of the observer's eye. Since the brightness of illuminant B was about 25 percent lower in our arrangement, equal brightness for both illuminants was obtained by shortening the distance to the frosted glass plate for illuminant B. Since the visual field was already very large at the distance of

six inches from the frosted glass plate (used for lamp A), its enlargement at the closer distance from lamp B is of no consequence. For the brightness levels of 125, 200, and 620 F.C. the following exposure times were used: 0.5, 1, 2, 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100 seconds. The series of consecutive exposures was terminated as soon as the limit of the instrument (10 M.F.C.) was reached. Sometimes in order to determine the time necessary to reach 10 M.F.C. more accurately, intermediate exposure times were given. Nevertheless, the light adaptation time for 10 M.F.C. cannot be determined with the same accuracy as the thresholds below this upper limit. For the brightness level of 1,050 F.C. much shorter exposure times were used (0.5, 1, 2, 3, and so on seconds).

Three well-trained and seven less-well-trained subjects were used, the latter only for the 200-F.C. brightness level. These subjects represented the extremes of fast and of slow dark-adaptation times in a former series of 32 subjects.[7]

The readings were repeated for all or most exposure times. All light exposures were given as soon as the subject had reached the threshold value of 0.05 M.F.C. The relative light-adaptation thresholds agreed in most duplicate readings within 5 percent of the mean. If the discrepancy was greater the same exposure was repeated for a third time. The dark-adaptation-time readings (time to reach the threshold of 0.05 M.F.C.) agreed within ± 10 percent, greater discrepancies being due to interference of afterimages.

In the three trained subjects the same arrangement was repeated on four to six different days with a reversed order of lamp A and B. In the seven less-well-trained subjects the experiments were repeated on two different days.

Results

Course of light adaptation and of dark adaptation. Table 1 shows the average results of relative light-adaptation thresholds for exposure durations between

TABLE 1

Light adaptation (M.F.C.) average values

Subject	F.C.	Lamp	Exposure Duration (seconds)								
			0.5	1	2	5	10	20	30	40	50
S.S.	125	A	4.3	4.8	5.1	5.4	6.3	7.3	8.0	8.6	9.1
		B	4.1	4.4	4.7	5.2	5.6	6.1	6.9	8.0	8.7
	200	A	5.4	6.2	6.4	6.8	7.4	8.7	9.4	10	
		B	5.4	6.0	6.4	6.7	7.4	8.1	9.0	9.6	
	620	A	5.2	6.1	7.1	7.8	8.8	10.0			
		B	5.5	6.0	7.0	7.3	8.4	9.4			
	1050	A	7.2	8.4	9.5						
		B	7.5	8.4	9.1						
E.S.	125	A	4.6	5.1	5.7	5.9	5.9	6.8	7.5	8.1	9.0
		B	4.1	4.6	5.3	5.6	5.8	6.3	6.8	7.2	8.3
	200	A	4.4	5.4	6.4	6.8	7.6	8.2	9.9	9.5	
		B	4.2	5.0	5.8	6.3	6.6	6.8	7.6	8.4	
	620	A	5.4	6.8	7.6	8.3	8.7	9.4	10		
		B	5.1	6.6	7.7	8.2	8.4	8.9	9.7		
	1050	A	7.2	8.8	9.5	10					
		B	7.9	8.4	8.9	9.6					
S.B.	125	A	6.4	7.1	7.8	8.5	9.4	10			
		B	6.2	6.9	7.9	8.5	8.9	9.5			
	200	A	8.3	9.5	10.0						
		B	8.0	8.8	9.2						
7 subjects	200	A		4.2	5.1	6.0	6.7	7.7	9.0	—	
		B		3.9	4.8	5.6	6.2	7.1	7.5	—	

TABLE 2

DARK-ADAPTATION TIME (SECONDS, AVERAGE VALUES) TO REACH 0.05 M.F.C.

Subject	F.C.	Lamp	Exposure Duration (seconds) 0.5	1	2	5	10	20	30	40	50
S.S.	125	A	14	13	20	25	32	47	64	86	93
		B	13	14	17	24	29	34	39	58	75
	200	A	14	17	24	30	37	45	58	67	
		B	15	24	25	32	42	46	63	67	
	620	A	13	15	22	27	38	64			
		B	13	18	22	27	35	55			
	1050	A	21	26	41	45					
		B	17	23	33	35					
E.S.	125	A	20	23	30	33	46	61	85	112	128
		B	17	21	24	29	32	49	59	73	93
	200	A	23	30	41	48	60	83	115	145	174
		B	23	30	40	46	50	61	73	94	124
	620	A	31	39	48	53	78	108	144		
		B	28	32	45	51	64	96	110		
	1050	A	36	49	66	102					
		B	39	48	63	85					
S.B.	125	A	24	30	37	44	50				
		B	20	27	33	34	39				
	200	A	40	46							
		B	33	43							
7 subjects	200	A	—	25	31	39	45	57	77	—	
		B	—	25	35	37	40	47	62	—	

0.5 and 50 seconds, for the purpose of general orientation as to the magnitude of changes. The longer exposure times at the 125- and 200-F.C. brightness levels are omitted. The figures are averages of 4 to 6 experiments in subjects S. S., E. S., and S. B., and averages of 14 experiments on 7 subjects in the last two lines. It will be noted that the wide threshold range from 0.05 to 4 or more M.F.C. is passed through within less than 0.5 second, while the further increase is much slower. Table 2 shows the corresponding average values of the duration of dark adaptation necessary to reach the level of 0.05 M.F.C.

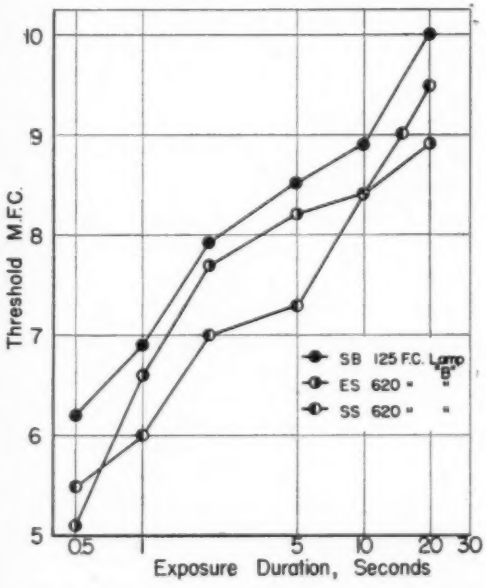

Fig. 1 (Simonson, Blankstein, and Carey). Average light-adaptation curves in three well-trained subjects.

The average curves of light adaptation in most instances show a sigmoid shape, except at the highest brightness of 1,050 F.C., where the speed is too rapid for our intervals of exposure durations. Figure 1 shows the average light-adaptation curves for 620 F.C. with subjects E. S. and S. S., and 125 F. C. for subject S. B., because his speed is of approximately the same order at this lower brightness level. The curves were obtained with lamp B; however, there were no differences between lamps A and B in this

respect. For a duration of exposure between 2 and 5 or 10 seconds the light-adaptation speed is slower than before or after. The shape of the curves is, of course, largely determined by the logarithmic abscissa of the exposure time, but the sigmoid contour is also present with linear coordinates. Figure 2 shows a sigmoid contour also in the corresponding dark-adaptation time, due to a less-pronounced

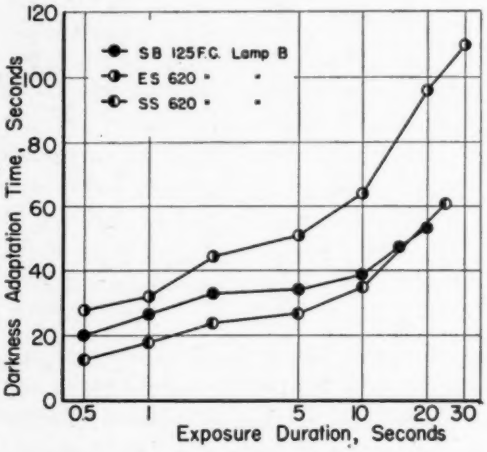

Fig. 2 (Simonson, Blankstein, and Carey). Average dark-adaptation curves for three well-trained subjects.

increase of dark-adaptation time when the duration of exposure was between 2 and 5 seconds.

The comparison between tables 1 and 2 and of figures 1 and 2 shows a general relationship between light and dark adaptation, in that with increasing exposure time and brightness the relative light-adaptation threshold increases, whereas the dark-adaptation speed decreases. Furthermore, with lamp B light adaptation is slower, whereas dark adaptation is faster at the longer exposure times.

This apparently good agreement does not hold, however, for the details of the course of light and dark adaptation. In the single experimental series we found frequently that in two or more consecutive exposures of increasing durations the thresholds of light adaptation or the dark-adaptation time remained the same. Irregular increase of the threshold with increasing duration of exposure was present in almost all experiments, as is also revealed in the sigmoid contour of the average curves.

The frequency of plateaus was greatest at the lower illumination levels of 125 and 200 F.C. (in 12 out of 20 experiments with subjects S. S. and in 12 out of 15 experiments with E. S.). In subject S. S., the plateaus (mostly of only two consecutive exposure durations) occurred between 1 and 5, rarely 10, seconds' exposure time, corresponding to threshold values between 5.5 and 7.0 M.F.C. In subject E. S., the plateaus were, in general, of longer duration, up to four consecutive exposure times, corresponding to threshold values from 5.2 to 7.2 M.F.C. Rarely were plateaus observed at higher threshold values or longer exposure times. At 620 F.C. and 1,050 F.C. brightness, S. S. showed no plateaus, whereas there were plateaus of somewhat shorter duration in 6 out of 12 experiments with subject E. S., at thresholds between 8 and 9 M.F.C. No plateau was observed at 1,050 F.C. The plateaus occurred with both illuminants, A and B. Subject S. B., who had a much faster light-adaptation speed, showed no plateaus. The seven less-well-trained observers also showed no plateaus. Plateaus were observed for the total dark-adaptation time for two or more consecutive exposures and were even more frequent than those of the light adaptation; they were present in several experiments with S. B. and also in the seven less-well-trained subjects. Sometimes the plateaus of light and dark adaptation coincided in time, but often they did not.

In Müller's series there was a steady increase of the relative light-adaptation

TABLE 3

COURSE OF LIGHT AND OF DARK ADAPTATION IN SINGLE EXPERIMENTS

Subject	Date	F.C.	Lamp	Light Adaptation (M.F.C.) Exposure Duration (Sec.)								Dark Adaptation (Sec.) Exposure Duration							
				20	30	40	50	60	70	80	90	20	30	40	50	60	70	80	90
S.S.	3/2	125	B	6.8	7.7	8.2	8.8	9.2	9.8	10		30	31	50	90	85	88	85	
	4/13	125	A	7.0	7.5	8.4	8.8	9.0	9.6	10		33	33	60	95	95	90	93	
	5/21	200	B	7.0	8.3	8.9	9.6	10.0				47	47	50	45	45			
Dy.	6/22	200	B	5.2	8.0	8.7	8.9	9.6	10			11	15	16	19	18	17		
E.S.	3/30	125	A	6.0	6.4	6.8	8.0	8.6	8.8	9.5	10	45	75	105	110	120	145	180	225
	4/5	200	B	6.0	7.2	8.2	8.4	9.2	10			60	70	100	105	140	215		

threshold (first readings) up to 40 minutes, even sloping up from 20 to 40 minutes' exposure, while the dark-adaptation time to reach 3 different threshold values (0.42, 0.047, and 0.005 Millilux) remained practically constant from 10 to 40 minutes' exposure time. A similar discrepancy was found in several experiments with S. S. (table 3), but was most pronounced in subject Dy, who had the fastest adaptation time. In subject E. S., the opposite tendency of excessive increase of dark-adaptation time at the higher threshold values was frequently observed: two typical experiments are shown in table 3. Table 4 shows a plateau of dark adaptation with increasing light adaptation in subject S. S. at shorter exposure times than those in table 3, and the opposite phenomenon (plateau of light adaptation, steady increase of dark-adaptation time), in subject E. S. Sometimes the plateau of dark-adaptation time and light threshold begins simultaneously, but terminates earlier in either one (table 4).

Comparison of the effect of brightness and exposure duration on light and dark adaptation. From the average curves of light and dark adaptation the light-adaptation time (seconds) necessary to reach 5, 6, 7, 8, 9, and 10 M.F.C., and the corresponding dark adaptation time (seconds) necessary to recover the level of 0.05 M.F.C. were determined by graphic interpolation. The results for the four brightness levels and lamps A and B are shown in table 5, the left side representing speed of light adaptation, the right side representing the corresponding speed of dark adaptation.

The increase of the speed of light adaptation with brightness is obvious. However, the recovery time (cone dark adaptation, right side of table 5) for a given threshold is not uniform, but depends on the conditions of exposure duration or brightness under which the given threshold has been obtained. In general the recovery time for a given threshold increases with exposure duration and consequently decreases with brightness, although a few minor exceptions are noted. Since increasing brightness at constant exposure time would prolong the

TABLE 4

DISCREPANCIES IN THE COURSE OF LIGHT AND OF DARK ADAPTATION

Subject	Date	F.C.	Lamp	Light Adaptation M.F.C. Exposure Duration					Dark Adaptation (sec.) Exposure Duration				
				2	5	10	20	30	2	5	10	20	30
E.S.	3/20	125	B	6.4	*7.2*	*7.2*	*7.2*	7.8	30	32	38	45	45
S.S.	4/27	200	A	5.5	6.5	7.0	8.5	9.0	28	*35*	*35*	*35*	56
E.S.	4/5	200	B	*6.0*	*6.0*	*6.0*	*6.0*	7.2	*40*	*40*	*40*	60	70
	3/30	125	A	*5.2*	*5.2*	*5.2*	6.0	6.4	*25*	*25*	35	45	65

TABLE 5

SPEED OF LIGHT ADAPTATION TO REACH THRESHOLD VALUES BETWEEN 5 AND 10 M.F.C. FROM 0.05 M.F.C., AND OF DARK ADAPTATION TO RECOVER THE INITIAL THRESHOLD OF 0.05 M.F.C.

Subject	Threshold M.F.C.	Light Adaptation (seconds)								Dark Adaptation (seconds)							
		125 F.C. Lamp		200 F.C. Lamp		620 F.C. Lamp		1050 F.C. Lamp		125 F.C. Lamp		200 F.C. Lamp		20 F.C. Lamp		1050 F.C Lamp	
		A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
S.S.	5	1.5	3.4							16	19						
	6	6.8	19	0.85	1.0	0.9	1.0			21	33	18	23.5	15	18		
	7	16.5	31.5	6.2	6.8	1.9	2.0			30	43	32	33.5	21	22		
	8	30	40	14.5	20	4.9	6.4	0.83	0.75	47	58	42	46	27	29.7	24	20
	9	49.5	60.5	24	30	11.3	15	1.55	1.95	81	83	51.7	62.5	43	45	36	33
	10	78	90	40	50	20	28	3	5	95	90	67	71	64	62	48	38
E.S.	5	0.9	1.5	0.8	0.9					24	23	28	29				
	6	10.5	13.8	1.5	3.0	0.68	0.75			45	41	34	41	35	33		
	7	22.0	35.0	5.8	22	1.2	1.3			66	66	50	64	40	39		
	8	38	48	16	35	3.1	3.0	0.7	0.6	106	88	75	84	52	47	42	41
	9	50	66	30	49	13.1	20.5	1.25	2.7	128	116	115	120	90	97	55	68
	10	75	95	47.5	65	29	37	4.5	9.5	185	162	207	180	147	123	100	102
S.B.	6	.34	.39							19	18						
	7	.93	1.03							29	27						
	8	2.5	2.3	0.44	0.5					38.5	33	37	33				
	9	6.8	10.5	0.75	1.5					47	38	43	46				
	10	14.7	20.0	2.0	3.2					61	51.5	55	53				

dark-adaptation time, it is obvious that the effect of increased brightness is overcompensated by the shortening of exposure duration. The duration of exposure appears to be a more important factor in regard to dark-adaptation time than the brightness level of light exposure.

In order to evaluate, in regard to light adaptation, the relative importance of exposure duration versus brightness, the product of duration and brightness (F.C.-seconds) was calculated for the various combinations of exposures and brightness levels. These values were compared at the following F.C.-seconds: 200, 620, 1,240, 3,000, 6,200, and 10,000. Table 6 shows the exposure time for each brightness level necessary to attain the same value of F.C.-seconds. For this comparison, values with lamp A at 10 F.C. were available from another study[6] up to the value of 3,000 F.C.-seconds. At the higher values of 6,200 and 10,000 F.C.-seconds lamp B was used for comparison because of the

TABLE 6

RELATIVE LIGHT-ADAPTATION THRESHOLDS AT EQUAL F.C.-SECONDS EXPOSURE

Subject	Lamp	10 F.C. Sec.	10 F.C.-Sec.	Th. M.F.C.	125 F.C. Sec.	125 F.C.-Sec.	Th. M.F.C.	200 F.C. Sec.	200 F.C.-Sec.	Th. M.F.C.	620 F.C. Sec.	620 F.C.-Sec.	Th. M.F.C.	1050 F.C. Sec.	1050 F.C.-Sec.	Th. M.F.C.
S.S.	A	20	200	5.5	1.6*	200	5.0	1	200	6.20	—	—	—	—	—	—
E.S.				3.56	*		5.4			4.35			—			—
S.B.				8.65			7.5			9.50			—			—
S.S.	A	60	600	7.48	5	625	5.4	3*	600	6.5	1	620	6.1	0.6*	630	7.4
E.S.				5.68			5.9			6.5			6.8			7.8
S.B.				10			8.5			10			—			—
S.S.	A	120	1200	8.52	10	1250	6.25	6*	1200	6.9	2	1240	7.1	1.2*	1260	8.6
E.S.				6.8			5.9			6.95			7.55			8.9
S.S.	A	300	3000	9.92	24*	3000	7.6	15*	3000	8.	5*	3100	7.8	3	3150	9.8
E.S.				8.16			7.1			7.9			8.3			9.7
S.S.	B	—	—	—	50	6250	8.65	30	6000	9.0	10*	6200	8.4	6*	6300	10
E.S.							8.3			7.7			8.4			9.8
S.S.	B	—	—	—	80	10000	9.8	50	10000	9.9	16*	9920	9.1	9.5	9975*	10
E.S.							9.5			9.05			8.0			10

* Interpolated values.

slower light adaption; with lamp A no value at 10,000 F.C.-seconds was available. Most threshold values in table 6 are direct readings, which are preferable even if there are minor differences in the F.C.-seconds values obtained. In a few cases (marked with *), the threshold values were interpolated. The threshold values are in general higher at both ends; that is, at the longest exposure time with lowest illumination level and at the shortest exposure time with the highest brightness level. The only exception is in subject E. S. who had steadily increasing thresholds with brightness at the smallest F.C.-seconds values of 200 and 620. The minimum threshold has the tendency to appear at higher brightness levels with increasing F.C.-seconds values including the values of E. S. The results of table 6 indicate that in regard to light adaptation, the length of exposure has a greater effect in raising the threshold at low levels of illumination; whereas at the higher levels of illumination, brightness is the more important factor. In general, the threshold is higher at the highest brightness level than at the longest duration of exposure. In this respect, light adaptation and dark adaptation are different.

Interindividual discrepancies between light- and dark-adaptation speed. Table 7 shows the light- and dark-adaptation speed of seven subjects, calculated for thresholds from 4 to 10 M.F.C. The values are averages of two determinations made on different days. At 10 M.F.C. threshold, the light-adaptation time for lamp A varies between 30 to 50 seconds, and for lamp B between 35 to 70 seconds. The dark-adaptation speed for the same threshold varies between 22.5 and 253 seconds for lamp A and between 18 and 235 seconds for lamp B. The seven subjects were selected as manifesting the extremes of slow and of fast dark-adaptation times in a series of 32 subjects,[7] in order to investigate whether the same subjects show also extreme differences in light-adaptation speed. This is obviously not the case. Table 5 shows similar discrepancies between the three well-trained subjects. The light-adaptation speed of S. S. and E. S. is approximately the same, that of S. B. very much faster. The dark-adaptation speed is fastest in S. B. and slowest in E. S.

In regard to the total dark-adaptation time for equal exposure duration, the values of S. B. are closer to those of E. S.

TABLE 7

LIGHT- AND DARK-ADAPTATION SPEEDS (SECONDS) AT DEFINITE THRESHOLD VALUES (M.F.C.), OBTAINED IN SEVEN UNTRAINED SUBJECTS WITH 200 F.C. BRIGHTNESS (AVERAGE OF 2 EXPERIMENTS)

M.F.C.:	4 Lamp		5 Lamp		6 Lamp		7 Lamp		8 Lamp		9 Lamp		10 Lamp		
Subjects	A	B	A	B	A	B	A	B	A	B	A	B	A	B	
Dy	1.9	2.5	5.2	9.5	18	21	25.5	26	31	30	40	43	50	70	Light
Cu	1.2	1.2	2	2	4	4.8	6	12	14	22	25	31	35	45	Adapt.
Wi	—	—	—	—	1.6	1.6	3	3	9	10	17.5	20	30	35	"
Sch	—	1.5	3	4.9	6	12	14	18	20	27	28	35	40	50	"
Ba	0.8	1.2	2	3	4.5	4.0	15.	20	25	35	33.9	42.5	40	55	"
Be	2.5	5	7.5	19	17.5	24	23.5	31.5	28.5	38.5	34	42	41	51	"
Du	—	—	—	—	1.5	1.5	5	7	18	19	30	31	40	40	"
Dy	15.8	12.2	15.0	12.5	17.0	12.0	19.5	13.5	21	15.5	22.5	16.5	22.5	18	Dark
Cu	25.5	21	26	27	27	27	29	28.5	39.5	32	56	42	77.5	61	Adapt.
Wi	—	—	—	—	41	48	51	56	66	67	81	85	122	132	"
Sch	—	12.5	13.5	13	15	22	27	26	36	51	50	56	50	72.5	"
Ba	48	80	72.5	83	100	85	122	115	135	170	190	216	253	235	"
Be	14.5	20	19.5	22	26.3	27.5	28.3	38.5	29	38.5	39	41	50	46.5	"
Du	—	—	—	—	28	28	30	23	44	40	45	40	67	51	"

than to those of S. S. (table 2), since the faster dark-adaptation speed compensates for the faster light-adaptation speed in this subject. This illustrates that measurement alone of dark-adaptation time after standardized exposure cannot reveal the true individual dark-adaptation speed.

The correlation coefficients between light and dark adaptation were calculated for the 10 subjects at the thresholds of 6 and 9 M.F.C. and 200 F.C. brightness. It was expected that a slower light adaptation would correspond to a faster dark adaptation. The coefficients were +0.22 and +0.2 for lamp A and +0.37 and −0.1 for lamp B. There is no significant correlation between individual light- and individual dark-adaptation speed.

TABLE 8
DAILY VARIATIONS OF LIGHT AND OF DARK ADAPTATION

Subj.	F.C. Lamp	1944 Date	Light-M.F.C.	Adapt. Time	Dark Adapt. Time	F.C. Lamp	1944 Date	Light-M.F.C.	Adapt. Time	Dark Adapt. Time
S.S.	200 B	3/10	8.4	30	83	620 B	2/8	8.0	15	45
		3/13	8.2	20	35		3/24	8.0	10	35
		4/27	8.4	20	50		4/5	8.2	5	34
		5/8	8.1	30	37		5/2	8.1	2	17
		5/18	8.2	10	47		5/23	8.3	10	23
		5/21	8.3	30	47					
E.S.	620 A	1/27	9.0	20	110	1050 A	3/24	9.0	1	45
		2/1	9.0	10	100		4/11	9.2	2	70
		3/10	8.8	10	70		4/13	9.0	2	60
		3/13	8.8	5	55		5/8	8.8	0.05	30
		5/18	9.0	10	60					
		5/21	9.0	20	90					
S.B.	125 B	2/9	8.4	10	36	200 A	2/2	8.7	2	55
		2/11	8.3	5	35		2/4	9.0	1	45
		2/23	8.4	2	35		5/3	9.0	1	42
		4/3	8.6	2	25		5/5	9.0	1	42
		4/15	8.5	5	32					
		5/9	8.5	5	42					

Discrepancies of daily variations of light and dark adaptation. Table 8 shows a few examples of daily variations of light and of dark adaptation in the three well-trained subjects. For each experiment the time to reach a certain threshold value during light exposure and the corresponding dark-adaptation time is compared at two brightness levels for each subject. Only direct readings are given in table 8, so that the threshold values differ slightly, but are still equal within the experimental error. It can be seen that the daily variations of light and of dark adaptation do not coincide. There is a tendency to longer dark adaptation with slower light adaptation. This tendency is consistent with our results (table 5) that a longer exposure duration at the same threshold level tends to prolong dark-adaptation time. However, this tendency alone cannot explain the discrepancies in the daily variations of light and dark adaptations in table 8. Discrepancies in the daily variations between light and dark adaptations occurred also in the experiments with the seven less-well-trained subjects.

The effect of spectral distribution on light and dark adaptation. Table 1 shows that the threshold values are lower with lamp B than with lamp A at the higher thresholds, whether they are obtained

with longer exposure times at lower brightness or with shorter exposure times at higher brightness. This is consistent with our former results[7] of faster dark adaptation with illuminant B after much longer exposure times of two minutes. The superiority of lamp B, however, is not so evident at the shorter exposure times. Obviously, only the secondary slower part of light adaption is clearly influenced by the effect of spectral distribution, while the effect on the initial fast process is doubtful. In the average results from seven subjects light adaptation is slower throughout the whole range of exposure times with lamp B. However, the difference between lamp A and lamp B increases with exposure duration.

In regard to the corresponding duration of dark adaptation (table 2), there is a marked tendency to faster dark adaptation with lamp B at the longer exposure times, the only exception being in subject S. S. at 200 F.C. At the short exposure times of 0.5 and 1 second, most differences between lamp B and lamp A are within the experimental error.

Table 5 may be used to decide whether the faster dark-adaptation time with lamp B can be explained as a consequence of the slower light adaptation with this illuminant, or whether an additional effect on dark adaptation is present. It is plain that a faster light adaptation will produce a longer dark-adaptation *time* even if the actual dark-adaptation *speed* is the same.

Since in table 5 the dark-adaptation time is compared for the same threshold values, the actual dark-adaptation speed is obtained, and the influence of different light-adaptation speed is eliminated. It seems that different individual and brightness trends occur in lamp B and lamp A. The effect of lamp B on light adaptation appears to be more consistent than the effect on dark adaptation.

All seven less-well-trained subjects except Du had a slower light-adaptation speed with lamp B, either throughout the whole range or at least at the higher M.F.C. thresholds. The effect of lamp B on dark-adaptation speed differed in different subjects. It is interesting to note that individual differences existed in regard to the effect of spectral distribution on light- and on dark-adaptation speed.

Comment

Although light-adaptation threshold and corresponding dark-adaptation time increase with brightness and with exposure duration, our results reveal numerous discrepancies between light adaptation and dark adaptation. The increase of dark-adaptation time with increasing exposure duration is not always parallel to the increase of the relative light-adaptation threshold in the same experimental series. Daily variations of light and dark adaptation do not coincide, and there is a lack of correlation between individual dark- and light-adaptation speed. The discrepancy in the daily variations is not surprising, since Hecht[1] observed that the daily variations of the cone and of the rod segment of the dark-adaptation curve may not coincide.

The occurrence of plateaus or of an irregular slope in the increase of relative light-adaptation thresholds and of dark-adaptation time with increasing light-exposure time is probably only an expression of quantitative differences of the same phenomenon. An increase of less than 5 percent of the threshold value in the subsequent exposure duration would still fall into the limit of experimental error. However, the sharp break during the first 0.5 second is best explained with the transition from α to β adaptation.[9] Schouten and Ornstein[9] assume that there are at least two different processes of light

adaptation with different parameters. Although a basic photochemical process during light adaptation is certainly present, the pure photochemical relationship between light and dark adaptation is interfered with by several unknown factors. This bears out Hecht's[1] prediction that further suppositions are necessary to describe some visual data. Our results concern cone light and dark adaptation only, and no direct transfer on rod adaptation should be made. However, the whole range of rod adaptation is passed through very rapidly during light exposure even at somewhat dim illumination levels, so that the change of brightness sensitivity occurs in the range of the cones after exposure times as short as 1 second. This does not exclude, of course, that the rod threshold increases simultaneously, although overshadowed by the changes of cone sensitivity. However, it cannot be expected that the relationship between rod dark adaptation and cone light adaptation will be closer than that between cone light and cone dark adaptation.

In a previous paper,[6] the light penetration through the eyelid was different when calculated for light and dark adaptations, so that we assumed that light adaptation and dark adaptation might be different not only in direction but also in nature. The present results support this conclusion. Dark-adaptation time for a given light threshold increases with the exposure duration necessary to reach this threshold. This is consistent with the observations of Elsberg and Spotnitz[10] on recovery of visibility from glare. Obviously, dark adaptation is involved in this process. Our results confirm Schouten and Ornstein's[9] finding that different rates of recovery can exist for any sensitivity level and may be regarded as additional evidence for the view[11] that a given light threshold cannot be regarded as an equivalent for the concentration of photosensitive material. While increasing exposure duration is a more important factor than increasing brightness for the dark-adaptation time, the effect on light adaptation is different.

There are two practical applications of our results: one is concerned with the technique of dark-adaptation measurements, the other with the appraisal of the glare effect. It can be concluded that the currently used method to standardize conditions for dark-adaption measurements is not adequate. Usually a standardized light-exposure duration of from one to several minutes is given, after which dark-adaptation time is measured. Due to the lack of correlation between light and dark adaptation speeds, the initial threshold from which dark adaptation starts is different in different subjects. There is some possibility that individual differences will be somewhat levelled at longer exposure durations, but this assumption is neither safe nor supported by the trend of our curves. The present method of measuring dark adaptation is roughly comparable to an attempt to study the oxygen debt after muscular exercise without knowing the work load. There are two ways of measuring the actual dark-adaption speed: (1) to vary the brightness so that light adaptation speed is comparable, or (2) to vary exposure duration at constant brightness so that the same threshold of light adaptation is attained.

To our knowledge, light and dark adaptations have not yet been used for a comparative study of the glare effect of different illuminants, although both are such fundamental visual processes that they should not be neglected in the appraisal of glare effects. The differences of light and dark adaptation obtained from two different illuminants, A and B, are encouraging for the use of this method. Our

previous results[7] with dark adaptation alone have been confirmed in this series. The dark-adaptation time is shorter after exposure to lamp B, owing to the changed spectral distribution of this illuminant. In addition, the present series allows a differentiation between the effect on light and on dark adaptation. This is desirable because of the lack of correlation between both processes. Four different combinations of glare effects are possible, which are illustrated by the following scheme, comparing two hypothetical illuminants or conditions x and y.

	Light Adapt. Speed	*Dark Adapt. Speed*	*Effect*
(a)	x = y	x faster y slower	Same glare effect during exposure; faster dark-adaptation time in x
(b)	x faster y slower	x = y	Greater glare effect in x during exposure; dark-adaptation time longer in x as a consequence of the faster light adaptation (higher threshold)
(c)	x faster y slower	x slower y faster	Concordant: Greater glare effect in x during exposure; dark-adaptation time much longer in x as added effect of faster light-adaptation and slower dark-adaptation speed
(d)	x faster y slower	x faster y slower	Discordant: greater glare effect in x is compensated in regard to the dark-adaptation time by the fast dark-adaptation speed

We have evidence for the existence of any one of the combinations (a) to (d) in our experimental material.

Using this scheme for analysis between lamp A and B for a rather wide range of relative light-adaptation thresholds, combination (b) is valid up to 9 M.F.C. This means that the diminished glare effect of lamp B is due to a slower light-adaptation speed without change of dark-adaptation speed. At the longest exposure duration, near 10-M.F.C. threshold, an additional effect on dark adaptation becomes apparent leading to combination (c). This tendency is rather obvious, although not yet quite uniform. Probably, at still longer exposure times, such as were used in our previous series, the concordant effect will be still more manifest.

The effect on light adaptation appears to be more important since it concerns the primary response that is responsible for the immediate state of visual sensitivity during light exposure, and also determines to a large extent the recovery time. It may be mentioned that light adaptation can be measured also by indirect methods such as fusion frequency of flicker,[12] brightness-difference thresholds,[13] or visibility.[14] Since different visual processes are used as criterion for light adaptation in the indirect methods, no mutual transfer of results is possible.

Summary

1. The effect of brightness levels (between 125 and 1,050 F.C.) and of exposure duration (varied between 0.5 and 100 seconds) on light and on dark cone adaptation was investigated in three well-trained and seven less-well-trained subjects, comparing usual frosted lamps (A) with an illuminant (Verd-A-Ray, lamp B) with reduced radiation at both ends of the visual spectrum.

2. Although dark-adaptation time increases with increasing light-adaptation

threshold, whether due to increasing brightness or exposure duration, there appears to be no consistent relationship between light-adaptation speed and dark-adaptation speed.

3. The dark-adaptation time for a given light-adaptation threshold tends to increase with increasing exposure duration.

4. For the speed of light adaptation the exposure duration appears to be of greater importance than the brightness only at low levels of brightness, whereas with higher illumination the brightness is more important.

5. The increase of the threshold during light adaptation and the increase of dark-adaptation time often do not run parallel.

6. In 10 subjects, no relationship between individual speed of light and of dark adaptation was noted.

7. Daily variations of light and of dark adaptation do not coincide.

8. The shorter dark-adaptation time of illuminant B, found in previous series, is confirmed. It is, at threshold values up to 9 M.F.C., a result of a slower light adaptation; at longer exposure times and higher threshold values there is an increasing tendency to an additional effect on dark adaptation. This is interpreted as increased tolerance of glare and faster recovery after glare with this illuminant.

9. Implications regarding a standard procedure for exact determination of dark-adaptation speed and analysis of glare effects have been discussed.

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THE CONTROL OF EXPERIMENTAL ANTERIOR-CHAMBER INFECTIONS WITH SYSTEMIC PENICILLIN THERAPY*

ARNO E. TOWN, LT. COMDR. (MC), U.S.N.R., FRANCES C. FRISBEE, LT. (JG) H(W), U.S.N.R., AND J. GORDON WISDA, PHM1C, U.S.N.R.
New York

The efficacy of penicillin in the treatment of ocular infections has been extensively studied in animal experimentation as well as by clinical application. Infections of the bulbar and palpebral conjunctivae, ulcerations of the cornea and corneal injuries accompanied by perforation[1-6] have been successfully treated by local application of penicillin. Gonorrheal ophthalmia in adults[7,8] has been promptly cured by intramuscular injection of penicillin. The successful response of orbital cellulitis and cavernous-sinus thrombosis[1,3,5,9,10] to penicillin, parenterally administered, has been reported. One of us (A. E. T.) has treated two patients with severe orbital cellulitis by the systemic administration of penicillin. Clinical improvement was rapid and recovery was uneventful. Scant attention has been given to consideration of the clinical efficacy of this agent in intraocular infections.[6] Von Sallmann[11] found the administration of penicillin by corneal bath and by iontophoresis to be effective in checking experimentally produced pneumococcal infection of the anterior chamber, even when delayed for 12 to 13 hours after inoculation. Treatments were given once or twice daily over a period of two to four days. When there was an associated lens injury, it was found that, to be effective, therapy must be started earlier and continued over an extended period of time.

In a previous communication, one of us[12] has reported on the concentration of penicillin in the anterior chamber of the rabbit eye following intravenous and intramuscular injection of the drug. The present paper concerns itself with the application of these findings in a study of the effect of intramuscularly administered penicillin in experimental streptococcal infection of the anterior chamber.

EXPERIMENTAL TECHNIQUE

The organism chosen for production of intraocular infection was a penicillin-sensitive strain of nonhemolytic streptococcus. Virulence of the organism had been increased by use of a culture medium containing 5-per cent mucin and by animal passage. The inoculum was a 24-hour culture in brain-heart infusion broth, diluted to one part in 10 or one part in 100 depending on the severity of the initial infection desired.

Rabbits were chosen as the experimental animal. With a fine hypodermic needle, 0.1 ml. of the diluted culture was injected through the upper quadrant of the cornea near the limbus into the anterior chamber. Within 7 to 12 hours a localized area of keratitis could be recognized which progressed rapidly to a generalized keratitis in the untreated animals. A conjunctivitis of varying severity usually manifested itself at the same time.

Penicillin therapy was initiated for each animal at such time as a definite keratitis could be recognized. The dose was approximately 5,000 units per kilo-

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gram of body weight, given intramuscularly every three hours.

Experimental findings

Control animals. Adequate control animals were included in the study to show that the untreated eye, infected by the technique described always went on to extensive generalized keratitis with resultant extensive scarring or complete opacity of the cornea; to an involvement of other parts of the eye; or, in some instances, to a panophthalmia.

Preliminary experiments. A series of preliminary experiments showed the limitations of penicillin to control ocular infection. Their value lies in contrasting the methods used with those in later experiments which were successful. In some of the very early studies, a fulminating infection, recognizable in three or four hours and rapidly progressive, was obtained following the use of excessively heavy inoculum. This difficulty was obviated by further standardization of the viruluence of the organism to allow the adoption of a uniform dilution of the culture for successive experiments.

Since it had been previously found that a marked increase in the concentration of penicillin in the aqueous humor of noninfected eyes following paracentesis,[12] one group of animals was treated by intramuscular injection every three hours combined with drainage of the anterior chamber twice daily. By the second day of treatment it became apparent that, in the presence of an infection, the ill effects resulting from puncture of the cornea and withdrawal of aqueous humor, with the consequent disturbance of normal equilibrium within the anterior chamber, was not counterbalanced by the higher concentration of antibacterial agent obtained by this procedure. With continued treatment, the infection became progressively worse and resulted in panophthalmia at the end of three days. Cultures taken on the fifth day were still positive for streptococcus.

In one group of animals, the infection was allowed to progress to a severe keratitis, involving the entire cornea, with massive purulent exudate in the anterior chamber, before treatment was started. Under penicillin therapy the keratitis did not progress further, but so much damage to the cornea had taken place that, from a clinical point of view, the results were discouraging. However, samples of the aqueous humor removed 48 hours after an eight-day course of therapy, were found to be bacteria free. Thus it was shown that anterior-chamber infections may be controlled and eventually eradicated by persistent treatment with penicillin, even when they are so severe and have persisted so long as to cause irreparable damage to the cornea.

Critical experiment. With the aforementioned limitations in mind, a critical experiment was set up with 13 animals. Beginning infection could be recognized in all animals seven hours after injection of the standardized inoculum of streptococcus into the anterior chamber. At that time, one infection was of sufficient severity for initiation of therapy following withdrawal of aqueous for culture. Penicillin injections were started in nine other animals during the next five hours, at such time as a definite keratitis became apparent. It was continued by intramuscular injection of 15,000 units (approximately 5,000 units per kilogram of body weight) every three hours for eight days. The remaining three animals were considered to have insufficient infection for inclusion in the study. It is interesting to note that eight days later one of these was found with pitting cicatrices of the cornea and severe iritis.

TABLE 1

BACTERIOLOGIC FINDINGS ON AQUEOUS HUMOR FROM TEN RABBITS WITH EXPERIMENTAL ANTERIOR-CHAMBER INFECTIONS TREATED WITH PENICILLIN INTRAMUSCULARLY

Rabbit No.	9978	9992	9998	9988	9990	9000	9984	9983	9979	9976
Prior to treatment	Pos.	Pos.	Pos.						Pos.*	
Day of treatment										
2	Pos.	Pos.	Pos.				Pos.		Pos.	
4	Pos.*	Pos.	Pos.						Neg.	
5							Pos.			
6	Neg.	Pos.*	Pos.	Neg.	Pos.*	Pos.*	Neg.	Neg.	Neg.	Neg.
8		Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.		

* Negative after 24 hours, positive after 48 hours incubation.

The bacteriologic findings on samples of aqueous humor withdrawn during the course of therapy are shown in table 1. Due to the previously mentioned altered character of secondary aqueous humor, samples were taken on only 4 of the 10 animals prior to therapy. Cultures were repeated on these four animals on the second day of therapy and, at that time, a fifth animal was added to this group which was to be subjected to frequent bacteriologic study. Samples were not taken from the eyes of the remaining five animals until the infection appeared, from clinical observation, to be under control. Cultures on all 10 treated animals were negative by the eighth day, at which time therapy was discontinued.

The tabulated clinical findings (table 2) show that, with one exception, the conjunctivitis had disappeared by the fifth day of treatment. Keratitis responded more slowly, but had cleared by the eighth day. There was recurrence in only one animal, brought about, in all probability, by trauma to which the eye was accidentally subjected on the ninth day after initiation of therapy. Hypopyon was present in seven of the infected eyes, appearing with or subsequent to the keratitis. In seven instances an exudate, purulent in nature, occurred in the pupillary area. It was absorbed slowly, assuming a veil-like membranous form, apparently attached to the margin of the iris, before disappearing. In one eye the exudate did not appear until the eleventh day and was thin and membranous when first observed.

TABLE 2

CLINICAL FINDINGS ON TEN RABBITS WITH EXPERIMENTAL ANTERIOR-CHAMBER INFECTIONS TREATED WITH PENICILLIN INTRAMUSCULARLY

Rabbit number	9978	9992	9998	9988	9990	9000	9984	9983	9979	9976
	Day of treatment on which finding was observed									
Conjunctivitis subsided	5	5	8*	4	4	4	4	5	4	5
Keratitis subsided	6	11†	8	8	6	7	8	4	5	7
Hypopyon observed	None	None	6	3	2	1	1	None	1	1
Hypopyon absorbed			11	8	5	11	7		5	4
Exudate in pupillary area	None	7	3	6	5	None	6	5	11‡	1
Exudate absorbed		16	16	13	8		12	16	16	8
Area of opacity (18th day)	Minute (3)	Small	None	Small	Small	None	Small	None	Minute (3)	Minute

* Conjunctivitis subsided fourth day but recurred on sixth. No recurrence after eighth day.

† Keratitis receded on the eighth day but flared up after accidental trauma on the ninth day, subsiding without recurrence on the eleventh day.

‡ Thin membranous exudate.

Daily examination of the eyes was continued until the eighteenth day, at which time two presented a normal appearance, without evidence of damage. In five instances there was present a small opacity of the cornea in the upper quadrant near the limbus. Two other eyes showed three minute areas of opacity in the same region. The consistent occurrence of opacities at the site where needle punctures were made as well as the fact that multiple areas of opacity were present only in those eyes from which aqueous had been successively withdrawn, points to the fact that they occurred as a result of penetration of the infecting organism into the cellular layers of the cornea along the needle track. In rabbit number 9998 no opacities of the cornea were present on the eighteenth day, but an opacity of the lens was apparent. This eye had responded slowly to treatment, and clouding of the aqueous was observed from the eleventh to the eighteenth day. Apart from damage to the lens, probably resulting from an injury by the needle at one of the punctures, this eye appeared normal.

Discussion

Results obtained in the treatment of infections of the anterior chamber by intramuscular injection of penicillin were in accord with what were to be expected from previous findings in regard to its concentration in the aqueous humor.[12] Because levels of therapeutic activity differ for various infecting organisms, it was suggested that a high dosage level would be required for adequate control of intraocular infection. Actual experimentation showed that a considerably lower dosage was adequate for the streptococcal infection studied.

Injection through the cornea into the anterior chamber of a minute quantity of an organism which had been standardized at highest virulence by animal passage and the use of mucin broth, resulted in an infection which could be duplicated at will. This technique is a modification of that used by Picot[13] and, later, by Von Sallmann.[11] It entails the use of local anesthesia only and is in contrast to the method used by Robson and Scott[2] in their work on corneal ulcers. They employed general anesthesia and injected the organisms under the corneal epithelium to produce a bleb in the cornea.

It would appear from accumulated evidence that conjunctivitis, corneal ulcers, and dacryocystitis respond favorably to local treatment with penicillin drops or ointment. In cases of perforating corneal ulcers, perforating injuries to the cornea accompanied by infection, and intraocular infections, the use of this type of local-penicillin therapy has met with considerable disappointment. In 1941, Abraham and his co-workers[1] reported a case of corneal ulcer that showed little improvement after treatment with penicillin drops. When corneal baths were substituted the response was prompt. Von Sallmann[11] used the corneal bath as well as iontophoresis, with success in infections of the anterior chamber. He found that this procedure did not result in demonstrable amounts of penicillin in the vitreous humor.[14] In a recent article, Dunnington and Von Sallmann[6] report success in arresting experimental infection of the deeper portion of the lens and of the vitreous by injection of penicillin directly into the affected part. Such treatment usually failed when an interval of 24 hours was allowed to elapse between the inoculation and therapy. In most instances no permanent damage resulted from the injection of penicillin solution, although a temporary opacity occurred. In the absence of infection, penicillin was injected

into the anterior chamber. This procedure resulted in a moderately inflammatory reaction which persisted for 24 to 72 hours.

These latter findings taken in conjunction with our own experiences that, in the presence of infection, the repeated withdrawal of aqueous was followed by extension of the infection and opacities at site of needle puncture, suggest the need for extreme caution in the use of a therapeutic method which entails puncture of an intact cornea in the presence of an infection. This in no way invalidates the previous observation[12] that an infection accompanying a perforating injury to the eyeball may be expected to respond more readily to systemic penicillin therapy than one in which there is no escape of intraocular fluid.

Since the efficacy of local penicillin therapy has been well explored by other workers, only systemic administration of the antibacterial agent was employed in the experiments reported here. Local application of the drug combined with an intensive regimen of systemic therapy offers promise to the clinician confronted with a serious ocular infection, provided the infecting organism is penicillin-sensitive.

Summary

1. Experimental infections of the anterior chamber of the rabbit eye which could be duplicated at will, were induced.

2. These experimental infections were controlled and, in the absence of lens injury, normal function of the eye was regained following intramuscular administration of penicillin.

3. Massive doses of the drug over an extended period of time were required for successful therapy.

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SOCIETY PROCEEDINGS

EDITED BY DONALD J. LYLE

MEMPHIS SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

February 13, 1945

HYDROPS OF THE CORNEA

DR. RALPH O. RYCHENER reported a case of keratoconus complicated by hydrops of the cornea in a young woman, G. B. W., aged 16 years. On March 6, 1944, she was referred for treatment, showing the typical clinical picture of hydrops of the cornea of the left eye.

Daily paracentesis was performed at the temporal limbus for two weeks. The corneal edema measured 2 to 3 mm. between Bowman's and Descemet's membranes. A 10-percent solution of sodium chloride was used as an eye bath every two hours.

The patient developed hematuria with a hemoglobin of 68 percent and was transferred to Saint Joseph Hospital for urologic treatment. This condition eventually cleared and she was returned home with the cornea still edematous and vision reduced to perception of moving objects. On November 4, 1944, the visual acuity in the right eye was 4/60, improved with a —9.00D. cyl. ax. 60° to 6/60. The visual acuity in the left eye was 6/60, improved with a —2.50D. sph. to 6/12.

The cornea of the right eye showed a marked conical protrusion with deep corneal scarring centrally. The cornea of the left eye showed a nearly normal contour, with corneal scarring to the temporal side of the pupillary area. Apparently, fibrosis following hydrops had compensated for the original keratoconus.

IRIDOCYLITIS FOLLOWING TATTOOING WITH GOLD CHLORIDE

DR. RALPH O. RYCHENER reported a case of tattooing of the cornea for cosmetic improvement which resulted in iridocyclitis and eventual enucleation of the eye. E. H. D., aged 32 years, was seen April 20, 1944. The left eye was divergent from a penetrating injury of the cornea at the age of seven years. There was a linear scar of the cornea at axis 75°, covering the entire pupillary area with anterior synechia below. A traumatic cataract was present. The tension was 40 mm. Hg (Schiøtz). The vision was nil.

The patient was most conscious of the cosmetic appearance of the eye and tattooing of the cornea was done on April 21st, the superifical layers of the scar being excised and 20-percent gold-chloride solution and 20-percent tannic-acid solution applied with an applicator to the eroded area. An excellent golden brown stain of the affected area resulted. However, the eye never became entirely clear and retained a foreign-body feeling which was found to be due to minute sloughing of the impregnated metal. Eventually, it was necessary to remove all of the precipitated gold tannate, but the eye remained irritable, photophobic, and painful, and on October 2, 1944, was enucleated.

SIDEROSIS FOLLOWING INTRALENTICULAR FOREIGN BODY

DR. RALPH O. RYCHENER reported a case of siderosis of the eyeball following a penetrating injury to the cornea and lens. H. R., aged 13 years, was seen for the first time on January 4, 1945, because of failing vision in the left eye for the

previous month. Visual acuity was reduced to moving objects because of a traumatic cataract with iron-pigment deposits on the anterior capsule. A minute penetrating scar was visible in the central cornea, with a corresponding minute hole in the anterior lens capsule, and a dark object approximately 1 mm. in diameter could be seen with the slitlamp in the lower lens cortex. Repeated X-ray pictures were negative for intraocular foreign body. The patient was unaware of any previous injury to the eye but a history was elicited in which he recalled breaking up some iron with a hammer about a year previously. On January 12, 1945, a simple extraction was performed with keratome incision.

The lens capsule could not be grasped for intracapsular extraction but the lens cortex was expelled completely and contained some rust fragments and an oxidized foreign body, 1 mm. in its greatest diameter, which was attracted by close approximation with the giant magnet. Postoperative convalescence had been normal and visual acuity was 6/24 with correction.

X-RAY BURNS COMPLICATED BY GLAUCOMA

DR. E. C. ELLETT presented J. R., aged 55 years, who was seen in December, 1943, with an epithelioma at the lower outer limbus of the left eye. The right eye was normal. The vision of the left eye was 6/60, unimproved with lenses. A growth had been removed from the upper part of the limbus of the left eye, diagnosed grade-3 basal-cell epithelioma, and the operation was followed by X-ray treatment. In January, 1944, the patient had a dermatitis, and there was a faint generalized stain of the cornea of the left eye (fluorescein). He had more X-ray treatment and said he received 5 treatments in one day and 10 on another day three weeks later. The patient was seen in January, 1945, when there were intense congestion of the eyeball, faint staining of the conjunctiva, and a dense white scar involving the lower and temporal conjunctiva and sclera. It was about 15 mm. in diameter and reached into the fornix. The pain was intense. The pupil was 7 mm. in diameter. The tension was 46 mm. Hg (Schiøtz). A retrobulbar injection of novocaine and repeated paracentesis did not control the tension, and an iridectomy was done on February 12th, which reduced the tension. The eye was less red and not painful.

SENILE ECTROPION AND BOWEN'S DISEASE

DR. E. C. ELLETT presented Mr. P., aged 69 years, who had ectropion of both lower lids and a small pterygium on the lower portion of the left eye. From the lower edge of the pterygium a gelatinous substance swept around the cornea below to the temporal side, overriding the cornea about 3 mm. In the discussion of this case, Dr. Rychener and Dr. McKinney called attention to the condition as described by Wescamp of Argentina in the Archives of Ophthalmology (April, 1944).

CORNEAL TRANSPLANTATION FOR KERATOCONUS

DR. J. WESLEY MCKINNEY reported the case of Miss G. H., aged 30 years, who was seen in 1938 for an advanced keratoconus in each eye. The corneal protrusion was so marked in the right eye that a contact glass could not be worn. A molded contact glass, however, was fitted for the left eye. Because of the apical corneal opacity the best vision obtained even with the contact glass was 20/50 partially. In 1941, the cornea of the left eye had be-

come so weakened and the cone so marked that a contact glass could no longer be worn. In 1942, the patient experienced a sudden marked impairment of vision, with pain in the left eye. Examination revealed edema and opacification of the central portion of the cornea involving all the layers. This was a typical hydrops of the cornea resulting from the leakage of aqueous into the cornea through cracks in Descemet's membrane. This cleared up entirely in almost one month with the use of drops of hypertonic sodium chloride. In January, 1944, a corneal transplantation was performed in the left eye. Because of the thinness of the cornea it was very difficult to make as accurate an incision as is usually possible. The graft healed well except for a small area temporally where a fine fistulous tract remained. In July, 1944, this corneal fistula was closed by means of surgical diathermy applied with a very fine needle. Following this procedure the anterior chamber remained flat for about one week. As the anterior chamber re-formed the intraocular pressure rose and was controlled with difficulty with miotics. Consequently, a cyclodialysis was performed. Since this operation the tension has remained normal, and the graft has cleared to almost normal transparency. The vision improved to 20/30 and J4.

Dislocation of lens into anterior chamber

Dr. Philip M. Lewis presented a patient with congenital subluxation of both lenses, one of which became dislocated into the anterior chamber.

E. A., a man, aged 30 years, was seen in September, 1944, for refraction. He was wearing —5.00D. cyl. ax. 90° for both eyes. His vision was R.E. 20/200, L.E. 10/200. Both eyes showed iridodonesis, and the lenses were subluxated upward and slightly medially. The media were clear and the fundi normal. Refraction showed that vision could be improved to R.E. 20/100 with —4.00D. sph.; L.E. 20/200 with —5.00D. sph. These lenses were prescribed, and he wore them with satisfaction for about two weeks. He then suddenly developed pain in his left eye and vision was blurred. A dense white haze was found in the center of the cornea involving the parenchyma and Descemet's membrane. The lens was in the same position as before. Dionin, atropine, and hot compresses were used, and the patient was examined for possible foci of infection. Some prostatitis was discovered and he was treated by his physician. The eye became free from pain, but the cornea still had deep vertical lines of opacities, and the vision was very blurred. He continued at his work, but about once a week he developed a severe pain in the eye which lasted several hours. During that period the vision became very blurred and the eye congested. As these attacks happened to occur each time on a Sunday he was not seen until after the attack was over.

The true nature of these attacks was not discovered until November, when he was seen during one which had not subsided quickly, but on the contrary had lasted over 24 hours. The cornea was very steamy, the intraocular pressure 65 mm. Hg (Schiøtz), and the lens was about three fourths in the anterior chamber. Thus the lens was jammed against the posterior corneal surface, and undoubtedly had been doing this to a lesser degree over a period of weeks and had been the cause of the deep corneal clouding. The patient was hospitalized immediately and within an hour the dislocated lens was removed. After healing was complete, the vision was 20/25 with +13.50D. sph. Everything seemed enor-

mous to him and although he saw clearly for the first time in his life, it was very difficult for him to wear the strong plus correction. It was necessary to wear a frosted lens over the right eye to prevent diplopia. After three weeks he had become accustomed to his new glass, the size of objects, and the clear appearance of everything. With his distance lens he could also read J7 at arm's length and could see to do anything he wished except read fine print. A bifocal was not prescribed as it was considered unwise in his case. A separate glass was ordered for reading, +16.00D. sph., with which he read J2.

Early multiple sclerosis

Dr. Philip M. Lewis presented R. L., a woman, aged 50 years, with possible early multiple sclerosis.

The patient was seen on December 4, 1944, with the complaint of blurred vision of her right eye for the past two weeks. She stated that she thought she had noticed a slight doubling of images at times. She had noticed no other symptoms and said that she was in good health. Vision was R.E. ability to count fingers, L.E. 20/25. The eyes were normal externally, the media clear, and the fundi normal except for a slight vascular sclerosis. The intraocular pressure was 18 mm. Hg (Schiøtz) in each eye. Tests with a red glass and small light in the cardinal directions of gaze failed to reveal any diplopia. The visual fields were fairly normal by confrontation method. It was felt that the condition was probably a retrobulbar neuritis. She was sent to her physician for a complete examination and advised to return for careful studies on the perimeter and tangent screen.

The visual fields of the right eye, taken several times during a two-month period, showed a moderate concentric contraction. The left peripheral visual field remained normal. Both eyes showed paracentral defects, and the right a very minute central scotoma. The fundi had remained normal, and there had been no other ocular signs of disease. Central vision varied in the right eye from counting fingers to 20/50, although it usually remained about 20/100. In the left eye the vision was 20/25. General physical and laboratory studies were entirely normal. The result of a complete X-ray examination of the skull, sellar region, and paranasal sinuses was normal. The patient was referred to a neurologist with the information that early multiple sclerosis was suspected, but his findings were completely negative. Large doses of thiamine hydrochloride were given without result.

Central choroidal disease

Dr. Philip M. Lewis presented a patient with a severe involvement of the macular region of unknown etiology. Mrs. W. J. W., aged 49 years, had been seen 10 months previously complaining that for two weeks she was seeing double and the vision of the left eye was blurred. Corrected vision was R.E. 20/20, L.E. 20/100. Examination showed that the right eye was entirely normal. In the left eye the cornea, iris, and lens were normal and the media were clear. The disc was normal and the retinal vessels were only slightly sclerosed. The macula was edematous, and there were several small hemorrhages and two small dull yellowish spots of exudate. Temporally near the equator were several old pigmented areas in the choroid. Complete general physical, dental, and laboratory examinations were negative. She was moderately sensitive to tuberculin.

Injections of tuberculin were given over a period of several months and for a while there was some improvement.

Vision improved to 20/50, and there were no fresh hemorrhages. Recently the condition had become worse. Fresh exudates, edema, and hemorrhages appeared in the macula, which had gradually become considerably scarred. A rather large hemorrhage also occurred along the inferior temporal vein below the macula. Among the various remedies tried in this case were injections of typhoid-H antigen intravenously, and large doses of vitamins. Nothing seemed to be of any value. It was questionable whether this was an inflammatory or degenerative condition.

Iridocapsulotomy for postoperative membranes

Dr. Philip M. Lewis reported two cases of secondary membrane from postoperative iritis.

Case 1. Mrs. A. R., aged 65 years, had a combined extracapsular cataract extraction in April, 1944. On the second postoperative day the cornea was hazy, the aqueous turbid, and the eye highly inflamed. Treatment consisted of sulfadiazene internally, milk injections, dionin, hot compresses, atropine, and suprarenin bitartrate. In spite of all efforts the borders of the coloboma became completely plastered down on a dense membrane. The intraocular pressure rose, and iris bombé developed two months after operation, necessitating transfixion of the iris. Following this, blood filled the anterior chamber and the eye was hard and painful. Paracentesis was performed and the blood evacuated. The eye gradually quieted down, leaving a very dense membrane. About four months after the original operation an iridocapsulotomy was performed, for which a narrow Agnew keratome and Berens modified Noyes scissors were used. Two months later the vision was 20/50 with +11.00D. sph. ⊂⊃ +2.00D. cyl. ax. 175°, and with +3.50D. sph. added she could read J6.

Case 2. Mr. T. B., aged 72 years, had a combined extracapsular cataract extraction of the left eye in April, 1944, and three days later a combined intracapsular extraction of the right eye. He went home on the eleventh day with both eyes in good condition, but a little cortex and capsular debris remained in the left eye. However, the fundus was clearly seen and no trouble was anticipated. He was given 1-percent atropine ointment to use in each eye once daily. On the fourteenth postoperative day the left eye became painful. Two days later there was a severe iritis with exudate and blood in the anterior chamber. A paracentesis was performed, with evacuation of the anterior chamber. Foreign-protein injections, dionin, hot compresses, atropine, and suprarenin bitartrate were employed. Gradually the inflammation subsided, but the pupillary space was filled with organized exudate. The borders of the coloboma were plastered to the membrane so that iris bombé with increased intraocular pressure developed, necessitating transfixion of the iris.

Four months after the original operation an iridocapsulotomy was performed. Five weeks later the vision was 20/25 with +9.50D. sph. ⊂⊃ +1.75D. cyl. ax. 180°, and with +3.00D. sph added he read J2.

Comment. It was felt that dense secondary membranes, especially in cases in which it was necessary to cut the iris, were operated upon more safely and more successfully by keratome incision and snipping with scissors than by ordinary discission with knife needles.

CHICAGO OPHTHALMOLOGICAL SOCIETY

February 19, 1945
DR. SAMUEL J. MEYER, *president*

SCIENTIFIC PROGRAM

POSSIBLE ERRORS IN THE USE OF THE CROSSED CYLINDER

DR. IRVING S. PUNTENNEY discussed certain aspects of Williamson-Noble's recent paper on "A possible fallacy in the use of the crossed cylinder." Part of this work was repeated and photographs were presented which demonstrated that it is easier to make comparisons with the crossed cylinder between a clear image and a blurred image rather than between two images, both blurred but to an equal amount. It was also shown that blurred letters are more easily read when they are elongated in the vertical rather than the horizontal.

The underlying principles of Sturm's conoid as it applies to refraction were also demonstrated by a series of photographs. These photographs were used to illustrate the nature of the two principal planes, the circle of least confusion, size and shape changes of the diffusion circles, and the effect of the crossed cylinder on the size of the diffusion circles in mixed astigmatism. Having shown that size changes in the test letters can be compared but not both size and shape changes, the essayist recommended that the crossed cylinder be used only after establishing meridional balance. The duochrome method seems to be the only known way of consistently establishing meridional balance, and correcting crossed cylinders may also be used as they offer the advantage of both speed and accuracy. The following points were emphasized in the summary:

1. Fogged letters are easier to read when elongated in the vertical.

2. Elongation of test letters can be avoided by establishing meridional balance.

3. When astigmatism is present all refractive errors can be reduced to mixed astigmatism by the addition of plus or minus spheres.

4. Most patients can compare size changes in the test letters, but few if any can accurately determine the difference when both size and shape changes occur.

5. Reducing the distance between the focal lines reduces the size of the circle of least confusion, the smaller diffusion spots being the clearer.

6. The duochrome method seems to be the only known way of consistently establishing meridional balance.

7. Correcting crossed cylinders offer the advantages of both speed and accuracy.

8. The optics of the camera are not directly comparable to the optics of the eye, but studies of this type are valuable for demonstration and teaching.

Discussion. Dr. William A. Mann said that the first true crossed cylinder was devised by Stokes, a mathematician, in 1849. It consisted of equal plus and minus cylindrical lenses so mounted that they could be rotated to any axis desired, and it was suggested that by this means astigmatism could be determined. Little attention appears to have been paid to this idea by refractionists, however, until in 1886 Edward Jackson proposed the use of a crossed cylinder or, rather, spherocylinder, consisting of concave spheres with convex cylinders. The crossed cylinder was at that time advocated for use in determining the strength of the cylinder, and it was not until some 15 years later that it was realized that the axis of the cylinder could also be determined with great accuracy by this method.

Owing to the activity of Jackson,

Crisp, and others, the crossed cylinder has been widely adopted as an aid in subjective tests, and is recognized as one of our most valuable adjuncts in the art and science of refraction. It must be borne in mind, however, that it is a subjective test, and its usefulness is therefore limited by the power of observation and discrimination on the part of the patient. All who use the crossed cylinder routinely have encountered patients who seem unduly unreliable in their replies on this test, and have assumed a lack of discriminatory ability as the basis for their difficulty. This probably remains true, but Dr. Puntenney in his paper has suggested possible reasons for error. By photographic means he has adequately demonstrated the necessity of having the eye under examination meridionally balanced if the crossed cylinder is to be an accurate means of determining the strength of cylindrical correction necessary. Dr. Mann said that he had had no experience with the duochrome test; that it sounds excellent on theoretical grounds, but even without this test it should be quite possible to have the spherical correction exactly balanced, especially when the patient is under a cycloplegic and not subject to the variations in accommodation which may occur in a manifest refraction.

He congratulated Dr. Puntenney upon the photographic demonstration and for emphasizing possible errors which may arise with improper use of the crossed cylinder. This in no way detracts from the important place of the crossed cylinder in subjective refraction, but does explain the need for its proper use. He asked Dr. Puntenney two questions: (1) Do these same errors arise in determining the *axis* of the cylinder as in the *strength* (this being the most important use for the crossed cylinder); and (2) in using the duochrome test, how satisfactory a method is it for establishing the meridional correction in a manifest refraction or post-cycloplegic refraction where accommodation may vary?

Dr. Irving Puntenney, in closing, said that regarding the subject of using the crossed cylinder for determining the axis, some work has been done on this, the approach being approximately the same. If meridional balance is maintained throughout the entire test, the axis determination will be more accurate, too, because the errors occur when both size and shape changes are introduced, thus leading to contradictory answers. He said that he had not used the duochrome until about one year ago; that he liked the old-fashioned vision box. However, at Dr. Gifford's suggestion he began to use it. He said he thought Dr. Gifford realized the possibilities of this long ago, and he was inclined to believe that it had helped him more nearly to approach the accuracy of Dr. Gifford's refractions.

Robert Von der Heydt.

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THROUGH ENGLISH EYES

The fall sunshine was warm and pleasant, the road to Hot Springs curved gently among the soft Virginian hills, and the dinner menu of The Homestead was in itself a justification for 4,000 miles of travel. To your newest Assistant Editor the November meeting of the American Ophthalmological Society was an unforgettable experience. It was at once a flash-back to far-off days of friendly international meetings and a promise of a saner future. How earnestly we in England desire a return to normality can only be realized by those of you who have seen the slow disintegration of prewar life and the gradual exhaustion of a stubborn people under burdens of controls, permits, rationing, universal conscription, and, finally, physical violence. To be snatched from all this to the friendly luxury and exhilarating vitality of America was to be awakened from a painful dream. But the awakening was all too brief, and the return to this land of poverty and postwar fatigue seems the more painful by

contrast. The memory, however, remains and should serve as a basis for a resolution to rebuild, to reconstruct, and to reorganize. One desideratum stands out, true for ophthalmology as for all other types of work, coöperation and collaboration. The Atlantic has narrowed to a span of hours, the continents are no longer individual nor safe in isolation. This should be the basis for an interchange of ideas, of personnel, of teachers, of students, of all that Britain and America have to give each other. This theme might well be developed into a study of the ways and means at present at our disposal. There is much to be done, and the times are urgent. It is good to be at home and planning for peace, not war.

Contrast and Cooperation. It is clear that at the moment the English-speaking world is fatigued but has already begun to realize the inevitable shortage of all medical practitioners, and of specialists. This is especially true of English ophthalmology, and the outstanding difference which a visitor to the United States sees there is in the size of the medical staffs of the teaching eye hospitals. Two examples will make this clear. Hospital A is in the United States. It has 75 beds and an annual out-patient attendance of 22,000. It has a total medical staff of 33, of whom 9 are resident and only 4 are absolute beginners. This makes each person responsible for about 15 cases a week, or, leaving resident staff out of the calculation, the visiting staff need only see at most 18 to 20 cases a week. Hospital B is in England. It has 50 beds and an out-patient attendance of 25,000 a year. Its staff is composed of eight medicals, namely two house surgeons, two surgeons, and four clinical assistants. Here each person must see at least 63 patients a week to keep things going. It is disparities of this nature which we in England must remedy even before we acquire the modern buildings and equipment we so much need.

Another and interesting difference between the American and British outlook in teaching would appear to be that on one side of the Atlantic the aim is the very thorough and complete training of a relatively few high-grade specialists, while on the other side we aim at basic instruction of a larger number for a shorter time, leaving it to the initiative of the few to obtain for themselves the final gloss and polish of academic distinction requisite for the highest grade. That the ideal lies in a combination of the two attitudes is undoubted, and we may expect the influx of demobilized aspirant ophthalmologists to force the issue of the creation of a new and definite policy. This will on our side certainly aim at co-operation and at fostering travel and interchange of students and staff and at the provision of varying types of instruction, both didactic and practical.

The spirit of reconstruction is abroad, and our respective governments are alive to the need for providing instruction for those whose careers have been interfered with by the war. It is hoped that a plan will emerge in the near future which will do something at least to remedy the serious lack of practitioners of our speciality.

Ida Mann.

THE INTENSIVE COURSE FOR OPHTHALMOLOGIC TRAINING

As everyone knows who takes any interest in the training of ophthalmologists, there is, at the present time, a demand for instruction in the basic subjects and a demand for residencies which is overwhelmingly greater than the existing facilities. Medical schools and hospitals

have been urged to increase their quotas, but the response has not made a dent in the mass of applicants (see the editorial by Cordes in the January number of the Journal).

There has been pressure to relax the requirements for certification by the Boards—indeed, the Advisory Board of Medical Specialties has recommended something of the sort. This the Ophthalmic Board will not do. And yet, something should be done for these eager and ambitious students. Some of them are poor stuff and will bring no credit to ophthalmology. But no doubt some of them will become ophthalmologists of the highest grade. How shortsighted is the policy that is governed by a determination to exclude the poor ones rather than by a resolution to help the good ones! The policy of the American Board of Ophthalmology is the sound one of excluding the poor ones not by refusing to consider any applicant whose opportunities have been poor, but by subjecting him to careful scrutiny in the examinations and passing men whose opportunities may have been poor but who have made such good use of these poor opportunities that they have become so well qualified as to deserve certification. The fact that they have been able to qualify in spite of obstacles is one more evidence of their superior quality.

From time to time, special or emergency problems arise which require special handling. The Board has consistently urged that laboratory and what may be called university methods of instruction are the ideal and that short courses are an abomination—unsound pedagogically and productive of a poor grade of practitioner. They are, however, better than nothing and are capable of really good results under favorable conditions. These favorable conditions are that the course be comprehensive, systematic, and fundamental—above all, with competent teachers. No one believes that clinical proficiency can be acquired in any way except by handling patients, certainly not by lectures. But for graduate students who have had four to six years of good medical training, including one or more years of interneship or private practice or experience in the Armed Forces, the basic subjects of ophthalmology can be taught successfully by lectures, reading, and quizzes. Those who have been practicing ophthalmology will find in such a course a fine opportunity to brush up on their basic knowledge to their great profit.

As secretary of the American Board of Ophthalmology, Dr. S. Judd Beach receives the full impact of the applications as candidates beseech him to tell them what to do, which way to turn. When Ida Mann told him of her success with a lecture course for rather large classes at Oxford, he hoped he had found a solution to the emergency problem of the basic training in fundamental nonclinical subjects preparatory for residencies, many of which make no provision of their own for this training.

There was no time to lose, and already, in less than a month, the organization has been built and is being incorporated. The executive officers are Dr. Beach, Dr. Lancaster, Dr. Terry, Dr. Gundersen, and Lt. Col. Phillips Thygeson. A list of 25 or more advisers has been secured, and a splendid staff of lecturers, assistants, and quiz masters. If the course is the success we hope for, it will be because of the exceptionally competent teachers recruited not only from Boston, but from Maine to California.

We shall see whether it is possible in nine weeks of intensive work to cover the ground thoroughly and adequately.

Walter B. Lancaster.

OPPORTUNITIES FOR TRAINING IN OPHTHALMOLOGY

As of October 1, 1945, the Council on Medical Education and Hospitals of the American Medical Association listed 73 hospitals where otolaryngologic residencies, 56 ophthalmologic residencies, and 43 combined ophthalmologic-otolaryngologic residencies are offered. They are not sufficient, at least in so far as ophthalmology is concerned, to take care of the overwhelming immediate demand, nor very likely to satisfy the demand when the confusion of the present subsides. The long term does not particularly concern us at the moment. The disturbing present requires our attention to see what can be done to alleviate this intolerable condition.

Unquestionably, the stimulating and new Veterans' Administration program for residency training will partly solve this problem for us. It deserves careful scrutiny, and the candidate for ophthalmology should not overlook this opportunity, which may be better in many ways than some of the residencies offered by civilian institutions in so far as clinical material, training, supervised study, and research in ophthalmology are concerned.

At a recent meeting of the Advisory Board for Medical Specialties, Dr. Paul Magnuson, representing the Medical Department of the Veterans' Administration, mentioned that during the next 50 years about 18 million men and women will have been taken care of by the Veterans' Administration hospitals. It is general knowledge that the Veterans' Administration is building and planning to build its hospitals as near to medical centers as possible in order to take advantage of the greatest collection of good doctors. Most of these areas are to be found adjacent to a university and medical school. Members of medical faculties of these schools will take active part in helping to staff the hospitals and in assisting in the residency-training program. The clinical material is very great and embraces all age groups. The exservice patients deserve the best of medical care and will get it, if the wise policies of Maj. Gen. Paul R. Hawley, Surgeon General of the Veterans' Administration, are followed. The battle is uphill and difficult, for there are many politicians, professional and amateur, whose philosophy has nothing to do with the ideals of good medical care, and their opposition is a delaying one. Generals Bradley and Hawley deserve every help and great commendation. One has faith that the public, if it knows the facts, will overwhelmingly back up these plans, everywhere.

To be sure, it will take a number of years to complete the building of new veterans' hospitals. However, the old ones are active, and residencies in ophthalmology in them are now available. Reorganizations of the staffs are being carried out, and new attending men and consultants are being appointed. It is good, too, to know that the problems of ophthalmology are in the capable hands of Dr. Trygve Gundersen, formerly consultant in ophthalmology, Mediterranean Theater, and to the Surgeon General of the Army, who has recently been appointed to the post of Chief Consultant in Ophthalmology to the Veterans' Administration. He is charged with the responsibility of organizing the ophthalmic services in the veterans' hospitals. These duties include matters of equipment, choice of consultants, and supervision of the residency-training program for ophthalmologists. It speaks well for the future that this able leader in ophthalmology is at the helm.

The ophthalmologists who are assigned

as attending men to the eye services of these hospitals have great opportunities not only for giving excellent care to the patients but also for developing to a very high degree the teaching facilities of the institution. The best places for the training of residents and internes are those that give the best professional care to the patients.

Let us return for a moment to the matter of the combined eye, ear, nose, and throat residencies mentioned before. A few of these are undoubtedly excellent and offer good facilities for men and women who are planning to do combined work. It is conceded that in small communities, particularly, there is a need for the eye, ear, nose, and throat specialist. There is one advantage at any rate, such an individual is never mistaken for an optometrist by the public. However, the average combined specialist has shown himself in the Army to be poorly equipped for top-flight ophthalmic work, and since these men came from civilian life the findings would be similar for the specialty as a group.

Perhaps some or many of the institutions giving a combined residency can be persuaded, during the emergency shortage of training facilities, at least, to divide their service into two, one for ophthalmology and the other for otolaryngology. This would be profitable to them in that more efficient service could be given, and a valuable boon to the neophyte ophthalmologist seeking a residency, particularly if he had had a basic course beforehand. The probable result would be a raising of the standards of ophthalmic practice among those doing part-time otolaryngology. It would mean a longer term of training for those seeking to be accomplished eye, ear, nose, and throat men; but there is no short cut without the sacrifice of training and skills.

Elsewhere in this issue* will be found an announcement from the American Board of Ophthalmology pertaining to preceptorships. It clearly establishes the policies of the Board in this matter, and puts it up to the student to make a wise choice of a preceptor. It recalls to mind a very attractive phase in the early history of medical education. It would have been a priceless privilege to be chosen pupil on one end of a log with Ernst Fuchs on the other, had he been available. Many a young man in the old days became a fine physician, trotting around with his preceptor on calls and in the office. A good preceptor must be very scarce. He has a reputation as a preceptor to establish and maintain, and if the pupil has to be wise in his choice, the preceptor should be most careful in his, too; for there is something very intimate and very filial in the relationship. One often judges the father by the son, and the son's manners are but a reflection of the old man's influence. A good preceptorship can be like an invaluable heritage, a poor one like a mismated marriage. It can generate affection, loyalty, and respect or it can produce evil fruits on both sides. A responsive, talented, and eager pupil brings great joy to the preceptor's heart, and in this lies his reward for a difficult task. The future career of his pupil will be followed and supported for the rest of his days. He will know that some measure of immortality at any rate will be his for a time because the preceptor comes to life again at each phrase of his pupil's speech, each turn of his pupil's hand, and each word of an old inherited patient's affectionate memory.

Derrick Vail.

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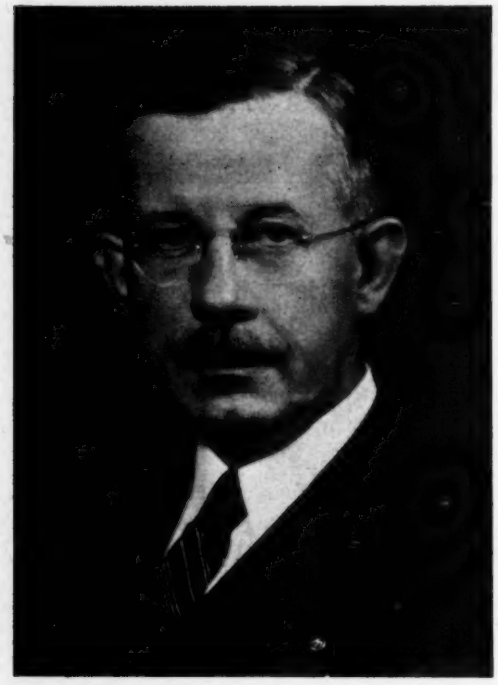
* See page 385.



OBITUARY

ALBERT D. FROST
(1889-1945)

Albert D. Frost, known to most of us as "Jack," was killed in an automobile accident near Monterey, Virginia, on his way home from the American Ophthalmological Society meeting in Hot Springs, Virginia, on November 15, 1945.

Born in Pittsburgh, Pennsylvania, on May 20, 1889, he received his preparatory education in the Pittsburgh schools, and in 1912 was graduated from the University of Pittsburgh with the B.S. degree.

He then worked in the steel mills for three years before he decided to enter medical school. Twice he enlisted in the Army and was twice sent back to medical school, and was graduated with the M.D. degree from the Western Pennsylvania Medical College in 1919. Following interneship at Bellevue Hospital, Cornell Division, New York City, he spent a year and a half as resident in the New York Eye, Ear, Nose, and Throat Infirmary. He became associated with the University of Pittsburgh and practiced ophthalmology in his home city until he moved to Columbus in 1924, to become an associate of Dr. Hugh Beatty.

Doctor Frost was a serious thinker. He possessed a keen clinical sense and dexterous hand to execute his plans. He was a resourceful and adroit surgeon. He loved teaching, particularly in the clinic, and his students were thoroughly instructed, in the use of the ophthalmoscope especially, and with contagious enthusiasm. He spared no effort nor convenience to give any student individual instruction merely for the asking. His place as a teacher will be difficult to fill.

"Jack" Frost was extremely friendly, loved to be with groups, and enjoyed, as much as anyone, to lead the chorus of his friends in amiable song.

He was an active member of numerous social, educational, and scientific organizations, contributing scientific discussions to the Columbus Eye, Ear, Nose, and Throat Society, Medical Review Club, Cleveland Ophthalmological Society, Ohio State Medical Association, American Medical Association, and, in particular, to the American Ophthalmological Socety, in which he yearly participated. His other memberships included the International College of Surgeons and American Academy of Ophthalmology and Otolaryngology. He ably served for 10 years as a director of the Ohio Commission for the Blind, the last five years as its president.

His fraternal organizations included the Scottish Rite of Free Masonry, Sigma Chi, Phi Rho Sigma, and Alpha Omega Alpha. He was a Son of the American Revolution.

His social and educational memberships included Crichton Club, Young Business Men's Club, Kiwanis, City Club,

Athletic Club, Scioto Country Club, University Club, and Faculty Club.

In recent years he was mainly interested scientifically in the study of papilledema and made several noteworthy contributions on this subject. His published papers were not numerous, but of the highest quality and influence. His death is a real loss to everyone in ophthalmology and is a great loss to his home community, Columbus, Ohio.

A. D. Ruedemann.

CORRESPONDENCE

Measurement of abnormal retinal correspondence (a simplified method)

Editor,
American Journal of Ophthalmology:

The measurement of abnormal retinal correspondence has often and unnecessarily been made to appear to be an abstruse subject. The idea that such is the case is apt to be fostered by the many articles on the subject in which it is stated or implied that one cannot determine the presence of abnormal correspondence or measure its degree without the use of a major amblyoscope or the afterimage test.

In using the major amblyoscope for this purpose, the examiner has the patient fixate alternately with one eye and with the other and adjusts the targets until they are in such a position that there is no movement of the eye on changing fixation. The patient is then permitted to adjust the instrument until the images of the targets are superimposed or until they change from a crossed position to a homonymous one or vice versa. The difference between this reading and the first one measures the amount of abnormal retinal correspondence. By this procedure there is obtained first an objective, then a subjective measurement of the angle of squint.

This can be done in the same, or less, time with no other equipment than is used in the examination of any patient with a disturbance of ocular motility. The squint is first measured objectively with the cover test, then subjectively with the Maddox rod, and the degree of abnormal correspondence is the difference between the two findings. The examination with the Maddox rod is facilitated by placing the rod before one eye and a red glass before the other; also by darkening the room somewhat.

The examination as just described can be made, of course, only in patients whose visual acuity in the poorer eye is sufficient to permit central fixation. If central fixation cannot be held, the objective measurement must be made with one of the less accurate methods (perimeter, Priestley Smith tape).

(Signed) A. Russell Sherman
671 Broad Street
Newark, New Jersey

How can the ophthalmologist divide the burden of his practice between himself and his office help?

Editor,
American Journal of Ophthalmology:

If a patient is going to consult an ophthalmologist or, as a matter of fact, any physician, he expects and has the right to expect to be examined and treated by the doctor of his choice. Most doctors are very busy men (or women); their working hours are filled to capacity, and it seems only natural that they try to distribute the work to a certain extent between themselves and their nonmedical help. The question comes up, how far this division can be carried without doing

injustice to the patient, on the one hand, and harm to the medical profession, on the other.

Primarily, the duties of a doctor's secretary are well defined. She is expected to operate the telephone, to receive and register the patients in the reception room, to take care of the technical part of the doctor's practice, keep the patient's records and files straight and up to date, send out the statements at regular intervals as directed by her employer, watch all sorts of supplies and order replenishments if something is running low, and assist the doctor in the minor operations which he performs in his office.

In case the doctor has hired a trained nurse or a technician in addition to the secretary the orbit of activities of such personnel naturally will be considerably wider. A trained nurse may give subcutaneous or intramuscular injections under the doctor's strict supervision and responsibility. A technician may relieve him of most of his necessary laboratory work. If properly qualified, a technician may conduct orthoptic treatment of patients.

However, there are certain diagnostic and therapeutic duties which belong strictly in the realm of the doctor and should be carried out by him. The first and extremely important part of the whole procedure is the taking of case histories, which requires not only a great deal of technical, psychologic, and medical experience but also establishes the cherished, inviolate, and much-spoken-of patient-doctor relationship (which, by the way, has nothing to do with fees or with any other material compensation). The nurse may establish a few facts; such as, for example, when the patient got his last glasses, if any, and by whom he was referred. It is, however, the understanding questioning by the doctor and the understanding interpretation of the patient's answers that build up a useful case history which alone furnishes the working basis for subsequent diagnosis and therapy.

It is not the purpose of this communication to discuss such duties as far as general practitioners and specialists in other fields are concerned. In what follows only the activities of ophthalmologists and their office staffs will be discussed. In my opinion all essential examinations should be carried out by the ophthalmologist—not by office girls or nurses—and these include not only ophthalmoscopy, retinoscopy, slitlamp examinations, but also subjective refraction, tonometry, and campimetry, to name only a few common diagnostic procedures.

I am very well aware of the fact that a certain number of eminent and nationally known ophthalmologists prefer to let an office girl or a nurse take care of some of these diagnostic procedures, especially tonometry and campimetry, the latter being a tedious and time-consuming undertaking if properly performed, which means that not only a peripheral field for gray objects, but also color fields, central field, enlargement of the blind spot, and possible scotoma are included in the examination. Every experienced ophthalmologist knows well what a vast amount of training and knowledge of physiology and anatomy, neurology, clinical pathology, and other branches of medicine are necessary to master the art of campimetry so thoroughly as to make the contribution of campimetry to the establishment of a proper diagnosis worthwhile.

To relate one of many rather typical experiences: A man, aged 30 years, was accompanied to my office by his wife. When he entered the examination room his somewhat ataxic gait immediately aroused suspicion. Questioning revealed that the patient had suffered a "nervous breakdown" four years ago, which meant

that he had shown a great variety of central nervous system symptoms, had been psychoanalyzed, had had his teeth pulled, his tonsils removed, and had had several pairs of glasses prescribed by an ophthalmologist; that he was sometimes better, sometimes worse. Eye examination revealed nystagmus in end positions, convergence paresis, definite pallor of the temporal sectors of both optic discs, deterioration of vision, and central scotoma for all values. When I telephoned the internist who had been taking care of the patient he hurried over to my office very much excited and depressed, bringing along several visual fields, old and recent ones, taken by the office girl in another ophthalmologist's office, which all showed normal peripheral limits. Based mostly upon the judgment of the ophthalmologist and upon the "normal" visual fields the diagnosis of malingering with an outspoken aversion to labor had been made, and the poor fellow had been treated accordingly for years. He died 11 months later from his multiple sclerosis. Had the ophthalmologist taken the trouble to examine the patient's eyes personally and properly the easy diagnosis would never have been missed.

There are in this country ophthalmologist's offices where admittedly the bulk of the refractive work is done by office girls who are only rather superficially acquainted with the fundamentals of refraction. I personally heard one eminent mid-western ophthalmologist, a medical school professor, at a special-guest lecture on the subject of glaucoma frankly advocate leaving tonometry in such cases up to nurses.

What applies to diagnostic measures is also true concerning therapy. I know offices of certificated ophthalmologists in which office girls without any medical training take charge the moment the doctor is leaving town, not only for a day or two, but for weeks, giving typhoid shots, removing corneal foreign bodies, treating critical cases of glaucoma, corneal ulcers, and other serious lesions. Well, some doctors apparently think that such procedures are not only legitimate but also proper. The office girls have worked for them and with them for several years and have seen so many cases of this and that that they are well capable (in the doctor's opinion) to take care of the doctor's practice while he is away. Of course, it is quite possible that a fairly intelligent girl with high-school or even junior-college education can learn a number of clinical procedures. She may learn to irrigate and probe a tear duct, open abscesses, curette chalazions. Such knowledge and dexterity undoubtedly can be acquired by laymen.

However, there is one very serious implication. We, as members of the medical profession, are always watching for infringements by various groups of lay practitioners; that is, those who do not hold an M.D. degree and are not licensed to practice medicine. We are very much opposed to any transgression of limits by them. Optometrists are not permitted to use cycloplegics, anesthetics, nor any other drug. Reputable firms engaged in the manufacture of contact lenses are required to engage the services of an ophthalmologist who has nothing to do but put a drop of an anesthetic in the eyes in order to enable the technician to make the cast.

I do not advocate that technicians and optometrists be free to use all sorts of drugs in patients' eyes; on the other hand, I am strongly against the increasing habit of permitting office girls, technicians, and nurses to do any kind of diagnostic and therapeutic work which should be carried out by the ophthalmologist himself. Certain sudden emergencies

such as drowning, road accidents, and the like always call for the immediate help of laymen where the physician is not at once available. During this war a U.S.N. pharmacist mate at sea on a submarine successfully performed an appendectomy, using for the most part kitchen utensils. Babies have been delivered by young medics in occupied territories who had no previous experience nor knowledge of obstetrics. An attentive intelligent nurse who has seen a large number of iridectomies might be able not only to diagnose an acute glaucoma attack but even to perform the iridectomy. And that might be permissible in an isolated jungle outpost without medical officer. But it certainly is strictly contraindicated under regular civilian conditions. We may start in training a girl in refractive work, in taking visual fields, in tonometry, but where do we end? The next step would be ophthalmoscopy, then minor surgery, and finally the doctor may just perform the more expensive cataract, glaucoma, and retinal-detachment operations, leaving the rest of the diagnostic and therapeutic office activities to a nonmedical staff. That may sound fantastic but it isn't. I could enumerate many amazing examples of that sort.

If we do not take a firm stand, we are not only degrading the reputation of our profession, but we also are deliberately furnishing formidable weapons to all the various groups of nonmedical practitioners who always claim that they are at least as good if not better than the Doctor of Medicine. They will seize any occasion to point to the fact that our diagnostic and therapeutic methods do not have to be acquired in grade-A medical schools, since they can be easily acquired and used by untrained lay personnel who never went through a regular course of training in Medicine nor had any postgraduate specialized training.

If doctors tell us that they do not have the time to perform personally all necessary diagnostic and therapeutic procedures, it can only be answered that no doctor can be forced to take more patients than he is able to handle, but that every doctor is compelled to diagnose and treat all his patients with the utmost care and that he must avoid everything that could be construed as unethical or detrimental to health-seeking humanity.

Especially now, when strong groups are working for introduction of systems of government-controlled medicine, it is of the utmost importance that the medical profession shall be in a position and eager to prove that we are really giving appropriate care to the whole population, that we are willing and able to take care of our own professional affairs without governmental interference.

Just as the specialists in all fields have established examining boards to which qualified specialists submit evidence of a minimum training, so it may become advisable to establish certain standards defining the duties of professional men in carrying on their practice. It will be better for the profession to take such matters in their own hands than to have them regulated later by governmental decree.

(Signed) F. Nelson
1121 North Tejon Street
Colorado Springs, Colorado

Military ophthalmologic meeting held at Crile General Hospital, Cleveland, Ohio, November 28-30, 1945

A military ophthalmologic meeting was held at Crile General Hospital, Cleveland, Ohio, on November 28 to 30, 1945. Those present were ophthalmologists in the

Army and Air Force installations who have been vitally concerned with ophthalmologic problems; those who have made noteworthy contributions while in the Armed Forces, although they may now be inactive or on terminal leave; and civilian consultants who have contributed to surgery concerning military ophthalmology.

Following a short speech of welcome by Col. G. V. Emerson, Commanding Officer of Crile General Hospital, and Lt. Col. N. D. Hall, Chief of the Surgical Service of that Hospital, the meeting was called to order at 9:00 A.M.

The first day's program consisted of a symposium on "Orbital reconstruction."

The morning of the second day's program began with a presentation by Lt. Col. M. E. Randolph, Eye Consultant, Surgeon General's Office, Washington, D.C., and Chief of the Department of Ophthalmology and the Rehabilitation Center for the Blind at Valley Forge General Hospital. His topic was "Rehabilitation of the blind." The remainder of the morning's program was devoted to other special topics and original ophthalmologic contributions by various members present.

The afternoon of the second day was in charge of Lt. Col. P. R. McDonald, Executive, Medical Service Branch, Air Surgeon's Office, Professional Division, Washington, D.C. The papers for this session were presented by the outstanding ophthalmologists from the Army Air Force Medical Centers.

A dinner was held at the Cleveland Athletic Club on the evening of the second day.

The morning of the third day was devoted to a symposium on "Plastic surgery of the eyelids." The afternoon session consisted of papers, demonstrations, and discussions concerning localization and removal of intraocular foreign bodies. All papers were limited to 20 minutes so that ample time for discussion was available.

The 41 ophthalmologists from various parts of the country who attended felt that the meeting was extremely worthwhile, and many expressed the hope that similar meetings in the different eye surgical centers could be held annually.

(Signed) Gilbert C. Struble,
Lt. Col. (MC) A.U.S.
Chief, Eye Surgical Center,
Crile General Hospital,
Cleveland 9, Ohio

PROGRAM

Wednesday morning, November 28, 1945. 8:30 Registration. 9:00: Col. G. V. Emerson, Commanding Officer, Crile General Hospital, and Lt. Col. N. D. Hall, Chief, Surgical Service, Crile General Hospital, "Welcome." SYMPOSIUM ON ORBITAL RECONSTRUCTION. 9:30: Lt. Col. Gilbert C. Struble, Chief, Eye Surgical Center, Crile General Hospital; "The use of tantalum and the Ruedemann eye implant in orbital reconstruction with presentation of cases;" 9:50: Discussion; 10:00: Lt. Col. E. L. Shiflet, Chief, Department of Radiology, Crile General Hospital, "The use of orbital tracings as an aid in reconstructive surgery of the orbit;" 10:20: Discussion; 10:30: Dr. A. D. Ruedemann, Chief, Department of Ophthalmology, Cleveland Clinic Hospital and Civilian Eye Consultant, Crile General Hospital, "Discussion on the use of tantalum and the implant eye in orbital reconstruction;" 10:50: Motion pictures of operative technique; 11:00: Capt. James Clifford, D.C., Chief, Acrylic Eye Laboratory, Crile General Hospital, "The processing of the Ruedemann implant eye;" 11:20: Discussion; 12:00: Luncheon at Officers' Mess, Crile General Hospital.

Wednesday afternoon, SYMPOSIUM ON ORBITAL RECONSTRUCTION. 1:00: Lt. Col. N. L. Cutler, Dibble General Hospital; "A new orbital implant;" 1:20: Discussion; 1:30: Major G. L. Witter, Dibble General Hospital; "The use of fascia lata in retro-tarsal atrophy following enucleation;" 1:50: Discussion; 2:00: Major A. J. Kreft, M.C., Billings General Hospital, "Orbital and ocular injuries produced by modern war missiles;" 2:20: Discussion; 2:30: Intermission; 2:40: Capt. B. F. Souders, Dibble General Hospital, "Elevation of orbital contents with plastic plates;" 3:00: Discussion; 3:10: Major G. L. Witter, Dibble General Hospital, "The use of dermal instead of fat implants in deep sockets;" 3:30: Discussion; 3:40: Major Victor H. Deitz, D.C., Chief, Plastic Eye Service, Halloran General Hospital, "The evaluation of recent ophthalmic concepts as related to the fabrication of plastic artificial eyes and implant devices;" 4:00: Discussion.

Thursday morning, November 29, 1945. 8:30: Lt. Col. M. E. Randolph, Eye Consultant, Surgeon General's Office, Washington, D.C., and Chief of the Department of Ophthalmology, Valley Forge General Hospital, "Rehabilitation of the blind;" 8:50: Discussion; 9:00: Major Trygve Gundersen, Eye Consultant, Surgeon General's Office, "The Vossious ring phenomena;" 9:20: Discussion; 9:30: Major H. G. Scheie, Crile General Hospital, "Ocular changes in scrub typhus;" 9:50: Discussion; 10:00: Intermission; 10:10:

Lt. Col. O. W. Thoeny, Beaumont General Hospital, "Malignant tumor of choroid simulating cyst of optic disc;" 10:30: Discussion; 10:40: Major L. J. Croll, Fletcher General Hospital, "End results in the treatment of retinal detachments at Crile General Hospital;" 11:00: Discussion; 11:10: Capt. John S. McGavic, Valley Forge General Hospital, "Visual disturbances associated with head injuries or the treatment of uveitis with artificial fever;" 11:30: Discussion; 12:00: Luncheon in Officers' Mess.

Thursday afternoon, AAF PROGRAM. 1:00: Lt. Col. P. R. McDonald, Executive, Medical Service Branch, Air Surgeon's Office, Professional Division, Washington, D.C., "Testing of night vision;" 1:20: Discussion; 1:30: Lt. Col. Brittain F. Payne, Randolph Field, Texas, "Recent ophthalmic problems in the Philippine Islands;" 1:50: Discussion; 2:00: Major J. H. Allen, University Hospital, Iowa City, Iowa, "Dendritic keratitis;" 2:20: Discussion; 2:30: Intermission; 2:40: Capt. Richard G. Scobee, St. Louis, Missouri, "Ocular muscle balance in flying personnel;" 3:00: Discussion; 3:10: Lt. Col. Phillips Thygeson, AAF, Tampa, Florida, "Blepharitis in military personnel;" 3:30: Discussion; 3:40: Major S. Rodman Irvine, AAF Regional Hospital, Tampa, Florida, "Physiology of ocular movements;" 4:00: Discussion; 4:10: Lt. Col. John L. Matthews, AAF, Randolph Field, Texas, Open; 4:30: Discussion; 4:40: Major D. L. Edwards, AAF, Miami, Florida, Open.

Thursday evening, 7:00: Informal dinner; Cleveland Athletic Club.

Friday morning, November 30, 1945, SYMPOSIUM ON PLASTIC SURGERY OF THE EYELIDS. 8:30: Lt. Col N. L. Cutler, Dibble General Hospital, "Correction of large notching defect of upper lid;" 8:50: Discussion; 9:00: Lt. Col. S. A. Fox, Newton D. Baker General Hospital, "Repair of lid margin deformities;" 9:20: Discussion; 9:30: Capt. A. E. Sherman, O'Reilly General Hospital, "Choice of procedure in ophthalmic-plastic surgery;" "Free skin grafts vs. pedicle grafts;" "Repair of notch and colobomatous defects;" "Surgery of the lateral and medial canthus;" "Reconstruction of the entire eyelid;" "Correction of deformities of the eye socket;" "Eyebrow and eyelash grafts;" "Filling of defects of the orbital margin;" 9:50: Discussion; 10:00: Intermission; 10:10: Lt. Col. N. L. Cutler, Dibble General Hospital, "Transplantation of vitreous;" 10:30: Discussion; 10:40: Lt. Col. O. W. Thoeny, Beaumont General Hospital, "A method of surgical treatment of recurrent pterygium;" 11:00: Discussion; 11:10: Major George A. Filmer, Beaumont General Hospital, "An alternate method of eyelash transplant;" "Treatment of relaxed eyelids following enucleation;" "A case of myositis of the ocular muscles;" 11:30: Discussion; 12:00: Luncheon in Officers' Mess.

Friday afternoon, SYMPOSIUM ON INTRAOCULAR FOREIGN BODIES. 1:00: Lt. Col. Riwchun, Walter Reed General Hospital, "Removal of intra-ocular foreign bodies (magnetic and repair of detached retina);" 1:30: Discussion; 1:40: Major H. G. Scheie, Crile General Hospital, "Oxygen injection of Tenon's capsule as an aid in localization of intraocular metallic foreign bodies;" 2:00: Discussion; 2:10: Major Albert Abbott, Valley Forge General Hospital, "The use of the Berman locator in the removal of intraocular metallic foreign bodies;" 2:30: Discussion; 2:40: Lt. Col. Gilbert C. Struble, Chief, Eye Surgical Center, Crile General Hospital, "Technical refinements in the removal of magnetic intraocular foreign bodies from the posterior segment of the eye;" 3:00: Discussion; 3:10: Intermission; 3:20: Dr. A. D. Ruedemann, Cleveland Clinic Hospital, Cleveland, Ohio, "The role of beta radium in the treatment of pathology of the anterior segment of the eye;" 3:40: Discussion; 3:50; Lt. Col. Edward E. Burch, O'Reilly General Hospital, "Administrative problems and procedures in military ophthalmology;" 4:10: Discussion.

ABSTRACT DEPARTMENT

EDITED BY DR. F. HERBERT HAESSLER

Abstracts are classified under the divisions listed below, which broadly correspond to those formerly used in the Ophthalmic Year Book. It must be remembered that any given paper may belong to several divisions of ophthalmology, although here it is mentioned only in one. Not all of the headings will necessarily be found in any one issue of the Journal.

CLASSIFICATION

1. General methods of diagnosis
2. Therapeutics and operations
3. Physiologic optics, refraction, and color vision
4. Ocular movements
5. Conjunctiva
6. Cornea and sclera
7. Uveal tract, sympathetic disease, and aqueous humor
8. Glaucoma and ocular tension
9. Crystalline lens
10. Retina and vitreous
11. Optic nerve and toxic amblyopias
12. Visual tracts and centers
13. Eyeball and orbit
14. Eyelids and lacrimal apparatus
15. Tumors
16. Injuries
17. Systemic diseases and parasites
18. Hygiene, sociology, education, and history
19. Anatomy, embryology, and comparative ophthalmology

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RETINA AND VITREOUS

Bettman, J. W. **Allergic retinosis.** Amer. Jour. Ophth., 1945, v. 28, Dec. pp. 1323-1328.

Damel, C. S., and Brodsky, M. **Arteriolar thrombosis of the retina.** Arch. de Oft. de Buenos Aires, 1943, v. 18, Sept., p. 429.

A man, 33 years of age, presented a thrombosis of a small arteriole in the macular region of the right eye, with moderate visual reduction. The neighboring arterioles showed discrete arteriosclerotic changes, but the rest of the retinal vessels were essentially normal. The patient was a chronic alcoholic and several days prior to the examination became unconscious and remained so for six hours. After considering embolism, endarteritis, periarteritis, and thromboangiitis obliterans, the authors arrive at the diagnosis of retinal arteriolar thrombosis, a nosological entity well established by Friedenwald. The pathology of the condition is briefly reviewed. (5 illustrations, 3 tables, bibliography.)

Plinio Montalván.

Dellaporta, N. **Spontaneous recovery from a retinal rupture after shotgun injury.** Klin. M. f. Augenh., 1942, v. 108, May-June, p. 363.

A man, 48 years of age, was accidentally hit in the right eye by a pellet from a shotgun. It was assumed that the pellet had pierced the sclera and lodged in the interior of the eye, although roentgenograms were not available. The fundus showed a grayish-white pear-shaped mass protruding from the retina. Adjacent to that spot a small diffuse retinal hemorrhage was found. An attempt to find the pellet through an incision in the lower part of the bulbar conjunctiva was unsuccessful. Three weeks later the gray mass had disappeared and a V-shaped tear in the retina with cloudy curled edges was found. Vision was 6/9 and the field of vision normal. The hole in the retina gradually became smaller

and disappeared completely after two months without any treatment. (References.) F. Nelson.

Elwyn, H. **Diabetic retinitis.** Arch. of Ophth., 1945, v. 34, Sept., pp. 187-190.

Diabetic retinitis, or retinopathy, is an easily recognizable ophthalmoscopic entity characterized by small, round and irregular hemorrhages; sharply defined, white exudates in the deeper layers of the retina, due to hyalin and lipids; and yellowish-white, glistening exudates, due to deposits of cholesterol.

The ophthalmoscopic picture is at times complicated by changes in the retinal vessels and their consequences, such as aging, arteriosclerosis, contraction of small vessels, obstruction of a venous branch, and episodal arteriospastic retinopathy. There is no causal relation between these changes and those of diabetic retinitis.

Some of the cases of severe diabetic retinitis are characterized by large retinal hemorrhages which rupture into the vitreous. A few cases are also characterized by the proliferation in the retina and the vitreous of newly formed vessels, which are covered by a connective-tissue layer. This form of retinitis proliferans differs in its appearance and its genesis from the retinitis proliferans following the partial absorption of a hemorrhage in the vitreous.

It is his opinion that in its pathogenesis diabetic retinitis stands in close relation to the continuous hyperglycemia which is in all probability responsible for the condition in the capillaries resulting in hemorrhages.

R. W. Danielson.

Franceschetti, M. A. **Complete non-syphilitic sclerosis of the retinal vessels.** Bull. Soc. d'Opht. de Paris, 1939, Oct.-Dec., pp. 606-607.

A case of sclerosis of the retinal vessels in a man 49 years of age is discussed. He had had diminished vision in one eye since the age of six years, but severe eye symptoms did not develop until 25 years later. Then optic-nerve atrophy developed bilaterally with divergent strabismus, rotatory nystagmus, and complete sclerosis of the arteries and veins of the retina. The Wassermann reactions of the blood and cerebrospinal fluid were both negative. Cranial trauma might have produced this condition. It could also be a manifestation of atypical tapetoretinal degeneration without consanguinity of the parents. Morton R. Cholst.

Magitot, A. **Mechanism of the stellate retinopathies.** Ann. d'Ocul., 1941, v. 177, no. 11, pp. 395-414.

The many conditions which produce stellate retinopathies are basically due to circulatory disturbances with mechanical and chemical variants. These are hydromechanical pressure of venous and arterial blood, osmotic pressure, the composition of the blood, and the presence of toxic products. Cellular degeneration is brought about by the accumulation of toxic products in the fluids which bathe the retinal cells, especially in the inner layers. Anoxemia and other insufficiencies play an important part because of high retinal glycolysis. The macula is predominantly involved because of the radial arrangement of its vascular structure and nerve fibers. White exudates are largely due to fibrin deposits and the accumulation of granular detritus in macrophagocytic microglial cells. The cells, which frequently form large clumps, are crammed full of lipoids, and giant cells are common in clumps. Vascular lesions can almost always be found, par-

ticularly in the smaller arterioles and the vessels. Hemorrhages are due to transudation, and not to rupture of the vessel walls. Chas. A. Bahn.

Moeschlin-Sandoz, Y. **Histologic structure of the vitreous ring.** Klin. M. f. Augenh., 1942, v. 108, May-June, p. 310.

Vogt's vitreous ring is seen frequently in senile eyes and in axial myopia. Histologic studies of the structure of the ring formation have never been published. The author reports his histologic studies of three eyeballs which had shown prepapillary ring formation clinically. One eye was enucleated because of malignant melanoma of the choroid, the two others belonged to a 73-year-old male who died of an intestinal carcinoma. All three eyes showed identical histologic findings. There was spindle shaped splitting of the posterior hyaloid membrane with invasion of cells having the form, structure, and tinctorial characteristics of glia cells, which proves that the strand composing the ring formation as seen ophthalmoscopically is glial in nature. (9 microphotographs, 1 color plate with 3 figures, bibliography.) F. Nelson.

Reese, A. B., and Payne, F. **Persistence of primary vitreous.** Amer. Jour. Ophth., 1946, v. 29, Jan., pp. 1-24.

Terry, T. L. **Ocular maldevelopment.** Jour. Amer. Med. Assoc., 1945, v. 127, June 23, p. 582.

Over 10 percent of infants born very prematurely or weighing three pounds or less can be expected to be blind from retrolental fibroplasia. A large mass of fibrous tissue develops in the hyaloid system. In addition to the mass one finds microphthalmia, shallow or absent anterior chamber, fetal blue iris, thin ciliary processes, persistent hyaloid artery, retinal separation, searching nystagmus, and photophobia. Of the probable causes listed, premature exposure to light is considered most probable and should be avoided. Treatment has been unsatisfactory. Many such eyes have been removed because the lesion was mistaken for retinoblastoma. Morris Kaplan.

Vancea, P., and Lazarescu. **Retinal folds caused by pressure from a mucocele of the frontal sinus invading the orbit.** Klin. M. f. Augenh., 1942, v. 108, May-June, p. 354.

The authors report a case of a large mucocele in a male 54 years of age which after two years duration had invaded the orbit, causing ptosis of the upper lid, proptosis and dislocation of the eyeball downward and outward, as well as restriction of the eye movements. Vision was reduced to 1/50. There was papilledema and retinal hemorrhage, and 10-12 horizontal and parallel folds of the retina were seen running across the macular region towards the disc. After surgical removal of the mucocele the eye returned to its normal position, and after ten days the retinal folds began to disappear. A hyperopic astigmatism found to be 2.5D. before the operation decreased to 2.0D. It is probable that the retinal folds as well as the increased corneal astigmatism were produced by direct pressure exerted by the mucocele on the eyeball. (1 fundus picture, bibliography.) F. Nelson.

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OPTIC NERVE AND TOXIC AMBLYOPIAS

Cooper, Fred. **Early diagnosis and treatment of primary optic atrophy.**

The Eye, Ear, Nose, and Throat Monthly, 1944, v. 23, Feb., pp. 68-71.

It is estimated that one tenth of our population is infected with lues and that five percent of the syphilitics develop tabes. It is believed that there are 50,000 cases of primary optic atrophy which are due to acquired lues. Prevention becomes an important problem, and to this end an early diagnosis and immediate treatment seem essential, although opinions differ on this point. The routine ophthalmologic procedures needed to establish a diagnosis are described in detail. The etiologic factors other than lues are enumerated as well as the theories concerning its pathogenesis. He mentions the possible relationship between neurologic changes and vitamin deficiency, and the theory that optic atrophy may develop as a result of nutritional disturbances of the nerve due to a luetic involvement of the blood supply of the optic nerve. The writer discusses different types of local and general treatment and points out that in unilateral luetic optic atrophy an early diagnosis and immediate treatment will in most cases prevent blindness in the fellow eye. Hyperpyrexia induced by malaria is a very efficacious method in the treatment of primary optic atrophy, and tryparsamide is contraindicated in cases where there is actual or potential damage to the optic nerve. (References.)

M. Lombardo.

Halbertsma, K. T. **Arteriosclerotic atrophy of the optic nerve.** Ophthalmologica, 1942, v. 104, Dec., pp. 289-300.

A case of bilateral arteriosclerotic opic atrophy in a woman 53 years of age is reported. The author discusses the theories concerning the mechanism of this type of atrophy. While some authors hold that the nerve damage is due to inflammation and stasis, the writer emphasizes the effect of pressure by arteriosclerotic vessels. The internal carotid and ophthalmic arteries as well as the vessels surrounding the optic nerve can damage the nerve.

Max Hirschfelder.

Lijó Pavía, J. **Prepapillary cyst.** Rev. Oto-Neuro-Oft., 1944, v. 19, Oct., pp. 125-131.

The author feels, as do other American observers, that these cysts originate from Cloquet's canal, and dilate as they develop. Two cases of typical prepapillary cyst are reported, both occurring in adults, one in each sex. They were best observed with the binocular ophthalmoscope, which readily demonstrated their anterior protrusion into the vitreous. Both patients had reduced vision, due probably to trophically unhealthy retinas resulting from partial closure of the arteries. Visual-field studies showed enlargement of the blind spot. The author reëmphasizes the value of binocular ophthalmoscopy for proper diagnosis and study. (4 retinographs, bibliography.)

Edward Saskin.

Loewenstein, A. **Cavernous degeneration, necrosis and other regressive processes in optic nerve with vascular disease of eye.** Arch. of Ophth., 1945, v. 34, Sept., pp. 220-226.

Several explanations of cavernous degeneration in the nerve have been advanced. The first is that the condition is the result of increased intraocular pressure; another that an abnormal lytic process is at work, the result of lysins which are liberated in the intraocular fluid of glaucomatous eyes (Elschnig). The author's findings lead

him to think that these two views are untenable, for cavernous change is not limited to the prelaminar and the immediately postlaminar part of the nerve. Usually the changes to be described are situated at some distance from the lamina cribrosa as well as near it. It has also been suggested that cavernous degeneration is the result of ascending degeneration in the nerve, a sequel of destruction of fibers at the disc associated with glaucoma, but in this case the cavernous change should present a continuity of degeneration, and its intensity should be greatest near the disc.

Loewenstein stresses that cavernous degeneration in the nerve is but one of the pathologic changes he has found in his study. The others were necrotic and sclerotic alterations.

This paper is a report of the histologic study of six glaucomatous eyes. Two points engaged the attention of the author as the result of the study of these six cases. The first is the occurrence of subretinal prolapse of optic-nerve tissue as a result of disease processes in the nerve. The second, and major, point of interest is the variety of forms of degeneration appearing consistently in the nerve in association with profound vascular disease.

Special attention, in the study, was given to the pathologic types of degeneration in the optic nerves, and the observations are described in some detail. Cavernous and necrotic degeneration were almost consistently found, and frequently the two changes occurred together. They were sometimes present in marked degree; at others they were inconspicuous. In some cases the disease process exceeded the boundaries of the nerve head and extended into the subretinal space.

These observations led Loewenstein to conclude that all these degenerative changes are the result of vascular damage with impairment of nutrition rather than the effect of increased intraocular pressure. R. W. Danielson.

13

EYEBALL AND ORBIT

Offret, G. **Anatomic study of a complex retrobulbar embryonic malformation.** Arch. d'Opht., 1945, v. 5, no. 1, p. 8.

The autopsy specimen studied came from the orbit of a newborn baby and was unique because of the presence of embryonic lid elements lying posterior to the globe. This poorly developed lid structure included such elements as skin, mucous membrane, hair follicles, and sebaceous, sweat, and mucous glands, as well as lobules corresponding to a rudimentary lacrimal gland. In addition there were a number of cysts, some probably representing dilated excretory ducts and others epithelial inclusion cysts. The author differentiates this formation from the ordinary dermoid cyst, which it resembles in many respects, on the basis of the multiplicity of the cystic cavities, the variety of the glandular structures, the resemblance to an eyelid, and the location in the muscle cone which is an unlikely one for a dermoid. He places the tumor intermediate between a dermoid cyst and a teratoma.

Phillips Thygeson.

Offret, G. **Primary malignant tumors of the orbital musculature.** Arch. d'Opht., 1941-42, v. 4, no. 1-2, p. 1; and no. 3-4, p. 81. (See Section 15, Tumors.)

Shoji, Y. **A case of primary epitheli-**

oma of the meibomian gland with invasion of the orbit and destruction of the globe. Arch. d'Opht., 1941-42, v. 4, no. 1-2, p. 32. (See Section 15, Tumors.)

Vancea, P. and Lazarescu. **Retinal folds caused by pressure from a mucocele of the frontal sinus invading the orbit.** Klin. M. f. Augenh., 1942, v. 108, May-June, p. 354. (See Section 10, Retina and vitreous.)

Velter, M., and Mergiot de Trigny, P. **Acute unilateral exophthalmos in a newborn infant.** Bull. Soc. d'Opht. de Paris, 1939, Oct.-Dec., pp. 569-570.

An infant, born one month prematurely developed a marked swelling of the upper eyelid, slight exophthalmos, and chemosis shortly after birth. Soon afterwards, the lower eyelid became swollen and chemosis and exophthalmos increased. Biopsy specimen revealed normal tissue, although gross inspection suggested an angioma. The cornea of this eye remained normal despite the severe protrusion. The infant presented no other signs of malformation. Morton R. Cholst.

Wright, A. D. **Pulsating exophthalmos.** Proc. Royal Soc. Med., 1945, v. 38, July, p. 479.

A case of traumatic pulsating exophthalmos is presented. Twelve days after the accident the internal carotid artery was ligated. Five minutes later hemiplegia and aphasia developed. The ligature was removed with prompt recovery of movement and speech. After seven days the common carotid was tied and the eye rapidly returned to normal. However, its sight was lost during the time between the two operations. Morris Kaplan.

14
EYELIDS AND LACRIMAL APPARATUS

Desvignes, P., and Offret, G. **Tumors of the lacrimal-sac region.** Arch. d'Opht., 1945, v. 5, no. 1, p. 25.

The diagnosis of lacrimal-sac tumor is difficult and is usually made only after invasion of surrounding structures. Two illustrative cases are reported. In the first case diagnosis of basal-cell epithelioma was made three years after removal of the sac for dacryocystitis. The authors believe it possible that the original stenosis was of neoplastic origin. In the second case the patient presented apparent mucocele of the sac with fistula formation. Tumor was suspected when the fistula failed to close normally under treatment. Microscopic examination revealed a basal-cell epithelioma with limited extension. The authors point out that lacrimal-sac tumors develop in two phases; first, dacryostenosis and dacryocystitis without unusual characteristics, and second, tumefaction. Tumor is to be suspected if the swelling is particularly hard or if there is spontaneous bleeding from the puncta. Tumors generally are not painful and there is no adenopathy. They may invade the nasal fossa, the orbit, or the skin. Phillips Thygeson.

Folk, M. R., and Brunner, H. **Edema of the eyelids in infections of the paranasal sinuses.** Illinois Med. Jour., 1945, v. 87, May, p. 245.

Lid edema due to infections of the paranasal sinuses might be due to an osteitis of the sinus walls or to thrombophlebitis of the anastomosing vessels. The former is more frequent in old people, the latter in young ones. The

frontal sinus is scarcely developed before the seventh year of life. In young children, therefore, lid edema is caused by infection of the maxillary sinus or the anterior ethmoid. In fact, lid edema is the most conspicuous sign of ethmoiditis in infants or young children. As the phlebitis extends backwards into the orbit, symptoms like high fever, exophthalmos, meningeal symptoms may appear and give the impression of a severe illness. These symptoms, however, disappear after simple conservative measures, such as shrinkage of the nasal membrane and the administration of sulfa drugs. If, however, the infection, while spreading backwards into the orbit, causes a subperiosteal abscess, the disease will continue for a longer time, and exophthalmos, displacement of the eye, and transitory muscle paralysis will become more prominent than the lid edema. Even in these cases surgery should be postponed as long as possible and one should rely on conservative measures and sulfa drugs. If one has the chance to see the lid edema develop, some conclusions of practical importance can be drawn. Maxillary-sinus infection involves the lower lid first, frontal and ethmoidal infections involve the upper lid first. Lid edema due to dacryocystitis is localized below the inner palpebral ligament, that due to ethmoiditis is localized above the palpebral ligament and over the frontal process of the maxilla from which the edema extends outward. In frontal-sinus infection the edema starts in the mesial or lateral portion of the upper lid.

Four case histories are given.

R. Grunfeld.

Leopold, I. H., Mahoney, J. F., and Price, M. L. **Symmetric defects in the lower lids associated with abnormalities of the zygomatic processes of the temporal bones.** Arch. of Ophth., 1945, v. 34, Sept., pp. 210-214.

The literature is discussed and a case report is given in which symmetric defects in the outer third of each lower lid, with absence of the zygomatic processes of the temporal bones, as shown roentgenographically, occurred in a grandparent, mother, and daughter. The ancestral history of these cases suggests that the defect was hereditary and that the trait is a dominant one.

R. W. Danielson.

Nuri Fehmi Ayberk. **Suppurative and cystic bilateral dacryocanaliculitis in an old trachomatous inflammation.** Göz Klinigi, 1945, v. 3, Aug., pp. 1-4.

A woman of 55 years, with old trachoma, had a suppurative canaliculitis with cystic dilatation of both upper eyelids. The author has seen this complication in only 30 out of 1,050 patients suffering from trachoma. (References.)

W. H. Crisp.

Shoji, Y. **A case of primary epithelioma of the meibomian gland with invasion of the orbit and destruction of the globe.** Arch. d'Opht., 1941-42, v. 4, no. 1-2, p. 32. (See Section 15, Tumors.)

15

TUMORS

Castañé Decoud, D. D'A. de. **Choroidal melanomas.** Anales Argentinosde Oft., 1944, v. 5, Oct.-Nov.-Dec., pp. 123-135. (See Section 7, Uveal tract, sympathetic disease, and aqueous humor.)

Dejean, C. **Unrecognized intraocular tumors.** Arch. d'Opht., 1941-42, v. 4, no. 1-2, p. 38.

The author calls attention to the difficulty of diagnosing intraocular tumors at onset, particularly in elderly individuals, and cites the relative frequency of tumors in eyes enucleated because of glaucoma. He reports his own series of 14 eyes, all enucleated for glaucoma. Two of these, on section, showed malignant melanoma of the choroid. The first of these was enucleated because of chronic glaucoma with repeated inflammatory exacerbations; vision was nil and the fundus could not be seen. The tumor was found to fill almost the entire vitreous cavity. In the second eye vision was likewise nil, and the fundus was obscured by a pupillary membrane. The entire vitreous was found to be replaced by a melanoma which had not been suspected.

On the basis of these two cases and a survey of the literature, Dejean reviews the objective and subjective signs of intraocular tumor. Among the subjective signs he includes localized field changes, metamorphopsia, micropsia, muscae volitantes, and phosphenes; as objective signs he describes corneal precipitates, pupillary paralysis, melanotic deposits on the iris, retinal detachment, and faulty transillumination. A sign of particular importance is the poor compressibility of the sclera over a tumor. The author stresses the frequency of tumor in progressive unilateral painful glaucoma which resists miotics. Phillips Thygeson.

Humayer, Karl. **Improvement of visual disturbances caused by pituitary tumor after mastoid operation.** Klin. M. f. Augenh., 1942, May-June, v. 108, p. 335.

A female of 36 years came for treatment of otitis media and beginning mastoiditis in January, 1933. Previously she had been given several X-ray treatments for a large pituitary tumor of extrasellar origin which had been diagnosed in 1929 and which had already destroyed the dorsum of the sella. Vision and bitemporal hemianopsia had improved after each treatment, but the improvements never lasted more than a few months. Mastoid operation eventually became imperative. When the necrotic parts of the bone of the sinus plate were removed the dura of the cerebellum was laid open. Five days after the operation the visual fields and the visual acuity improved, so that the patient could read again. After one year the visual acuity was 5/5 and 5/7 in the right and left eye, respectively, and the visual field of the right eye still showed a hemianopic defect for white and colors in the upper temporal quadrant. During the following eight years no further X-ray treatment became necessary, and the patient was completely free of any disturbances. The incomplete atrophy of both discs did not change. It is assumed that the success of the operation resulted from the removal of bony structures which produced a decompression of the brain, the optic nerves, and chiasm.

F. Nelson.

Lagrange, H. **A case of tuberculous dystrophic osteitis of the skull.** Ann. d'Ocul., 1941, v. 177, no. 7, pp. 263-270.

A male 37 years of age had a tumor of the right frontal region with normal vision, a left exophthalmos with optic atrophy, and a vision of 4/200. X-ray

studies showed a rarification of the right frontal bone and a similar area in the occipital region. A tumor biopsy specimen contained giant cells from which several tubercle bacilli were isolated. Guinea-pig inoculation tests verified the tuberculous etiology.

Chas. A. Bahn.

Monbrun, Offret, G., and Guillaume, J. **Value of examination of the sheath membranes in tumors of the optic nerve.** Arch. d'Opht., 1945, v. 5, no. 1, p. 8.

Careful examination of the meninges of the optic nerve in nerve tumors is strongly recommended. Two cases of optic-nerve glioma are reported by way of illustration. In both, histologic study of the tumors themselves was rendered difficult because of degenerative changes in the tumor substance, but examination of the meninges revealed characteristic tumor-cell infiltration. The detailed histologic study is documented by numerous drawings.

Phillips Thygeson.

Offret, G. **Primary malignant tumors of the orbital musculature.** Arch. d'Opht., 1941-42, v. 4, no. 1-2, p. 1; and no. 3-4, p. 81.

This extensive review in two parts is based on 25 cases from the literature, plus an additional two cases observed by the author. Five cases of fibroblastic sarcoma are described of which three were verified histologically and two were doubtful. The tumors were all in young subjects and involved three different rectus muscles. In each case diagnosis was made only after surgical removal. It was not possible to conclude as to local recurrence or metastasis, as postoperative observations were incomplete, but it is believed that such recurrences are the rule. In the five cases the clinical signs and symptoms varied considerably, while the microscopic picture was relatively uniform.

A single case of polymorphic sarcoma with total involvement of the superior rectus in a child of two years is reported. There were ten cases of rhabdomyosarcoma. Typical and atypical forms were recognized by the microscopic appearance. Of the ten cases, seven were in infants or young children, two were in adults. Two clinical types were noted; the first became superficial early and simulated palpebral, conjunctival, or limbic lesions; the second, whose neoplastic nature was discovered only on biopsy, remained deep and was evidenced by exophthalmos. These neoplasms recur readily and frequently become generalized. Radiotherapy is of value.

Only two cases of leiomyosarcoma are reported and in both the diagnosis was open to some doubt. Seven cases of round-cell sarcoma, of which six occurred in individuals of from 32 to 61 years of age, are recorded. The clinical picture of orbital neoplasm with exophthalmos was uniform in all cases. In general these tumors are radiosensitive and have a favorable prognosis. Adequate follow-ups were not available but local recurrence was noted in only one case and was relieved by radium.

The author states that reticulosarcomas of the orbit, and particularly of the orbital musculature, are extremely rare but he reports two cases, one of which was his own. This tumor is radiosensitive and the prognosis is good.

In a general discussion of the subject, Offret stresses the fact that nor-

mal muscle function is well maintained in spite of extensive invasion of the muscles and that disturbance is generally due to nerve involvement.

Phillips Thygeson.

Shoji, Y. **A case of primary epithelioma of the meibomian gland with invasion of the orbit and destruction of the globe.** Arch. d'Opht., 1941-42, v. 4, no. 1-2, p. 32.

The literature on malignant tumors of the meibomian gland is reviewed and the eight cases which have been reported from Japan are described in detail. The author's patient was a woman of 69 years who had a chalazion-like nodule of the right lower lid of five years duration. This tumor slowly increased in size until it surrounded the globe, destroyed the lower lid, and invaded the lateral half of the upper lid. It had grown to the size of a man's fist. Over the temporal part of the tumor the skin had disappeared, leaving a bleeding ulcer. The tumor on extirpation weighed 48 grams and surrounded the atrophic globe. Microscopic examination showed that the tumor was an epithelioma. Its origin from the meibomian gland was well shown by the lipoidal content of the characteristic cells, demonstrated by fat stains and by the polarizing microscope. The study is well documented by photographs and drawings.

Phillips Thygeson.

Vetter, Joachim. **A metastic choroidal carcinoma from cancer of the breast in a male.** Klin. M. f. Augenh., 1942, v. 108, May-June, p. 349.

Of the 150 cases of metastatic carcinoma of the choroid reported up to 1939 60 to 70 percent originated from primary tumors of the breast but only once in a male. The author saw a man of 69 years in whose left breast carcinoma with metatastasis in the axillary lymph nodes had been diagnosed two years previously. Operation had been refused. A large retinal detachment was found in the right eye. The eye was enucleated and the metastatic carcinoma of the choroid was demonstrated histologically. Subsequently the primary tumor was removed surgically but a roentgenogram revealed metastases in both lungs. (3 microphotographs. Bibliography.) F. Nelson.

Wiedersheim, O. **Two rare angiomatous lesions in the fundus.** Klin. M. f. Augenh., 1942, v. 108, March-April, pp. 205-213.

The author reports observations on two eyes that showed a mass of dilated convoluted vessels contiguous to the disc which extended out far beyond the macula. In one of them the anomalous vessels seemed to have extended into the depths as though connected with the choroid. A year later the vessels had collapsed and the swelling in the involved area had receded, presumably as a result of strangulation from pressure which the mass itself exerted on its blood supply.

The author speculates on the relations between racemose arteriovenous aneurysm and retinal angiomatosis and their theoretical significance. (4 figures, references.) F. Herbert Haessler.

16

INJURIES

Amsler, Marc. **Direct ocular lesions through skiing accidents.** Bull. Soc. d'Opht. de Paris, 1939, Oct.-Dec., pp. 595-599.

Fourteen cases of trauma to the eyes

due to skiing accidents are discussed. Direct lesions are produced by either the ski poles or the point of the ski itself. The lesions consisted of contusions and detachments of the eyelids, paresis of the ocular muscles, exophthalmos, enophthalmos, and various injuries to the eyeball itself. Nine eyes were rendered useless. The author declares skiing a most dangerous sport.

Morton R. Cholst.

Benkwith, K. B. **Eye injuries and diseases encountered during Iwo Jima campaign.** U.S. Naval Med. Bull., 1945, v. 45, Sept., p. 433.

The problems of the diagnosis and treatment, and some general observations of the 81 eyes injured in the Iwo Jima campaign are presented in moderate detail. In most of these there were recent, serious trauma with multiple infective foreign bodies in the eye and the surrounding tissues. Although the eyes were observed and treated for only one to three days before evacuation to the rear, the results were dramatic. In addition to the necessary surgical treatment, most patients received large doses of sulfadiazine orally, 30,000 units of penicillin intramuscularly every three hours, and penicillin applied locally. Calcium penicillin was freshly prepared in concentrations of 10,000 units to the c.c. and used topically, injected subconjunctivally over the whole globe, injected into the vitreous body in amounts of 0.2 c.c., and used as an irrigation solution of the anterior chamber. The very excellent therapeutic results are ascribed to the routine use of these heroic measures combined with very tight pressure bandages.

Morris Kaplan.

De Saracibar, Jose M., **Varices of Gent.** Arch. de la Soc. Oft. Hisp.-Amer., 1945, v. 5, Jan., pp. 50-53.

Gent described irregular dilations of the conjunctival blood vessels produced by the caustic effect of mustard gas. The author describes an eye with identical clinical picture though no history of contact with a caustic chemical could be obtained.

J. Wesley McKinney.

Esposito, A. C. **Ocular sensitivity to butyn.** Amer. Jour. Ophth., 1945, v. 28, Dec., pp. 1362-1364.

Jäger, A. **Eye injuries caused by owls.** Klin. M. f. Augenh., 1942, v. 108, May-June, p. 346.

A man of 55 years was attacked by an owl. In the right eye the lens became partially dislocated; the left eye sustained a conjunctival and scleral nonperforating wound. Vision in the right eye was first considerably reduced, but both eyes recovered full vision eventually. (Reference.)

F. Nelson.

Rouquier, A. **Amaurosis and amblyopia as a result of posttraumatic reflex sympathetic disturbances of the face.** Presse Medicale, 1945, July 28, p. 412.

The case of a soldier wounded by a mine explosion is reported. About 15 small pieces of stone had penetrated the skin of the face, chiefly on the left side. None of these had struck the eyes, penetrated the orbits, or damaged the optic nerves. The soldier had at no time lost consciousness and had not sustained a brain concussion. A bilateral blepharospasm, much more marked on the left side, developed during the days following the explosion, and at the same time the left eye became almost totally blind while vision in the right dropped to 3/50. The left pupil was smaller than

the right but reacted normally. Neurologic examination revealed sympathetic disturbances more marked on the left side. The electro-encephalogram showed alterations localized to the two prerolandic regions, more marked on the left side.

Treatment consisted in the injection of acetocholine and in cocaine applications to the middle turbinates. Under this regime the patient's difficulties slowly resolved so that vision had become normal in both eyes and the blepharospasm had disappeared two and a half months after injury. Repeated electroencephalograms continued to show abnormalities, however, but their extent diminished steadily. Rouquier states that this would have been called a case of hysteria a few years ago but that neurologists now recognize the reflex sympathetic nature of the lesion. The amblyopia is believed to be due to circulatory changes in the retina. Phillips Thygeson.

Sédan, J. **Total, unilateral, external ophthalmoplegia following electric short circuit.** Ann. d'Ocul., 1942, v. 178, no. 2, pp. 64-71.

No similar observation has been reported. An electrician, 27 years of age, was badly shocked when a short circuit occurred in a transformer which reduced a current from 5,000 to 110 volts. A total external unilateral ophthalmoplegia resulted, with partial paralysis of the seventh nerve. Improvement began about the forty-fifth day with slight restoration of the sixth-nerve function. All muscular function was entirely restored in four months.

Chas. A. Bahn.

Valerio, M. **Two rare cases of juvenile degeneration of the cornea.** Bull. Soc. d'Opht. de Paris, 1939, Oct.-Dec., pp. 612-614.

Two young men, 25 years of age, with no significant family history, each had a disciform corneal opacity. In one of them microscopic examination revealed gray-yellow polygonal elements in Bowman's membrane which had the appearance of a mosaic. In the other, microscopic examination revealed crystalloid deposits in the parenchyma of the cornea. The author believes that senile alterations can take place at an early age as an expression of a recessive hereditary degeneration.

Morton R. Cholst.

Wright, A. D. **Pulsating exophthalmos.** Proc. Royal Soc. Med., 1945, v. 38, July, p. 479. (See Section 13, Eyeball and orbit.)

17

SYSTEMIC DISEASES AND PARASITES

Balza, Jorge F., and García Querol, Armando. **Ocular changes in pregnancy.** Arch. de Oft. de Buenos Aires, 1943, v. 18, April, p. 216; June, p. 311; July, p. 356; Aug., p. 411; Sept., p. 464.

This is a very exhaustive review of the subject, appended by 65 detailed case histories and presented in the following sections: general considerations, glaucoma and pregnancy, myopia and pregnancy, intraocular pressure in pregnancy, pressure of the central retinal artery in pregnancy, visual fields in pregnancy, accommodation and light sense in pregnancy, ocular changes in septic abortion, ocular changes in hyperemesis gravidarum, retinal detachment in pregnancy, sudden blindness in pregnancy, hypertensive retinosis in pregnancy, ocular changes during labor and puerperium, case reports, and sum-

mary. From their studies the authors arrive at the following conclusions:

(1) Glaucoma is extremely rare in pregnancy. (2) Myopia may appear or if present may increase during pregnancy. Calcium metabolism probably plays an important role in this connection. (3) Intraocular pressure was found to be within normal limits. (4) The pressure of the central retinal artery was normal in all cases with normal systemic blood pressure and was increased in arterial hypertension. (5) No definite visual-field defects were found. (6) No investigation of accommodation and light sense in pregnancy could be carried out. (7) No ocular complications were observed in septic abortion. (8) Hyperemesis gravidarum was complicated with retinal hemorrhages. (9) Retinal detachment during pregnancy may be of three types: (a) ordinary retinal detachment occurring during pregnancy without symptoms of toxemia, requiring ocular surgery by the standard procedures; (b) retinal detachment with symptoms of toxemia, a typical complication with characteristic symptoms requiring immediate therapeutic abortion; and (c) retinal detachment occurring during or after labor in which a predisposing cause such as myopia is usually present. (10) Sudden blindness in pregnancy may be due to hysteria, but is usually associated with eclampsia, when the blindness may last hours or even days. (11) Hypertensive retinosis is the most frequent ocular complication of pregnancy. It appears usually during the second half. Its earliest signs are arteriolar spasms and increased pressure of the central retinal artery. If it appears before the fetus is viable and there is no improvement with systemic treatment, therapeutic abortion must be resorted to. When the retinosis appears after viability, if the retinal lesions are discrete and show a tendency to regression under treatment, it is advisable to await the termination of pregnancy; on the other hand, if the retinal lesions are extensive, with no improvement under systemic treatment, the pregnancy should be interrupted. (12) The normal eye tolerated pregnancy well. (1 diagram, 2 color fundus pictures, 8 fundus photographs, 4 tables, bibliography.)

Plinio Montalván.

Berens, C., and Cumming, E. L. N. **Nasal bacteriologic flora in eye patients.** Amer. Jour. Ophth., 1945, v. 28, Dec., pp. 1313-1321.

Cibis, P. **Cataract in neurodermitis disseminata.** Klin. M. f. Augenh., 1942, v. 108, May-June, p. 281. (See Section 9, Crystalline lens.)

Dollfus, M.-A. **Value of phlycentular conjunctivitis in the detection and prophylaxis of infantile tuberculosis.** Arch. d'Opht., 1941-1942, v. no. 1-2, p. 26. (See Section 5, Conjunctiva.)

Gersh, I., and Reich, N. E. **Arthritis, urethritis, and conjunctivitis (Reiter's disease.)** Urologic and Cutaneous Rev., 1945, Aug., p. 472. (See Section 5, Conjunctiva.)

Giqueaux, R. E., and Ochoa, R. G. **Ocular myiasis.** Anal. Argentinos de Oft., 1944, v. 5, July-Aug.-Sept., pp. 79-83.

A 3-months-old infant is discussed from whose right eye many larvae were removed. These worms presented themselves only when exposed to chloroform fumes. There was subacute

conjunctivitis, with the larvae residing in the folds of the plica semilunaris. A discussion of general myiasis and ocular myiasis follows. (2 illustrations.)
Edward Saskin.

McGraw, James L. **Marfan's syndrome with unusual complications.** Arch. of Opht., 1945, v. 34, Aug., pp. 112-113.

The author reports a case of Marfan's syndrome, occurring in a family in which three of six children were mentally deficient, and one of the three showed other congenital defects, among them, ectopic lenses.

The patient, a girl, had ectopic lenses, apathetic expression, prominent ears, thin, flat chest, winging of the scapulas, and spinal curvature. The tension was elevated in one eye with partial dislocation of the lens but was normal in the other eye in which the lens was completely dislocated. Seven months after a lens extraction from one eye a large anterior-chamber cyst developed associated with a rise in tension. The cyst was successfully destroyed by flushing it with 3.5 percent iodine solution. John C. Long.

Mukerji, A. K., and Bhaduri, N. V. **Gnathostome infection of the eye.** Indian Med. Gazette, 1945, v. 80, p. 126.

A Bengalee Hindu male 26 years of age complained of a dull, aching pain on the left side of his nose and left frontal region for a week. Next day a swelling appeared on the left cheek which spread to the left lower eyelid. Physical examination revealed orbital cellulitis, but normal vision. Two days later the cellulitis improved, the vision, however, dropped to perception of hand movement. Hemorrhages in the retina and in the vitreous were noted. Three days later a severe iritis with small grey nodules on the iris developed. The nodules soon disappeared but a definitely motile pigmented mass made its appearance on the iris. From the angle of the anterior chamber a worm of 2 1/2 cm. length was removed which belonged to the genus Gnathostoma (Nematoda). The parasite resembled the species described by Maplestone and differed somewhat from G. spinigerum and G. hispidum.

The parasite, and the life cycle of G. spinigerum are described. In Bengal men usually acquire it by eating raw or dried fish. R. Grunfeld.

Pérez Vélez, A. A. **Oral infection and ophthalmology.** Rev. Oto-Neuro-Oft., 1944, v. 19, Oct., pp. 141-143.

A concise, informative discussion of dental anatomy and physiology is presented. The intimate relationship between the orbital and dento-buccal vascular, lymphatic, and nervous systems may account for ocular disease due to dental foci of infection. In certain ophthalmic problems, it is wise to have a complete dental examination, including X-ray study, and to remove immediately any infections in the mouth.
Edward Saskin.

Radnot, Magda. **Eye findings in Cushing's disease.** Ophthalmologica, 1942, v. 104, Dec., pp. 301-307.

Adenomata of the anterior lobe of the hypophysis may compress the optic nerve and lead to bitemporal hemianopsia, edema of the retina, and retinal hemorrhages. The latter can be the result of arterial hypertension. In addition to these findings the author stresses the possibility for increased intraocular pressure due to disturbance

of the endocrine system. Three cases of Cushing's disease with swelling of the face, decrease in calcium of the bones, low sugar threshold, and arterial hypertension are reported. Two of them showed elevation of the intraocular pressure. Max Hirschfelder.

Schmelzer, Hans. **The problems of ocular tuberculosis and its treatment.** Arch. de la Soc. Oft. Hisp.-Amer., 1945, v. 5, Jan., pp. 24-42.

There are still many unsolved problems in the field of ocular tuberculosis. Cases of true caseous ocular tuberculosis are extremely rare. The great majority of chronic inflammatory processes in the eye are not true tuberculous affections but are tuberculoallergic. Occasionally allergy to other organisms is causative. The treatment, then, is directed toward desensitization by specific and nonspecific therapy. Rest and diet are fundamental adjuvants. Graduated injections of tebeprotein are preferred for specific therapy, guided by frequent blood counts which indicate the state of allergy by the white-cell picture. As nonspecific therapy, copper or gold is used intravenously, often with the addition of calcium. J. Wesley McKinney.

Schwartz, A. R. **Exophthalmic goiter in children.** Arch. of Pediatrics, 1945, v. 62, May, p. 214.

A case of exophthalmic goiter in a child two years and three months of age is reported because of the rarity of the condition. R. Grunfeld.

Shannon, E. W., and Soloman, J. **Bilateral temporal arteritis with complete loss of vision.** Jour. Amer. Med. Assoc., 1945, v. 127, March 17, p. 647.

In a patient with acute bilateral temporal arteritis all vision in both eyes was promptly lost. Resection of the affected portions of the arteries relieved all symptoms but the loss of vision. Fundus studies showed venous engorgement, blurred disc margins, papillary and retinal edema, threadlike arteries, and some minute hemorrhages. The cause of the ocular involvement is not clearly understood though it is suggested that the retinal artery undergoes the same pathologic processes which are found in the temporal artery. Morris Kaplan.

Spaeth, E. B., and Krewson, W. E. III. **Arteriovenous aneurysms in the region of the circle of Willis.** Jour. Internat. College Surg., 1945, v. 8, July-Aug., p. 313.

An anatomic and physiologic review of the circle of Willis is presented with stress on its ophthalmologic aspect. There are five types of aneurysm of this structure and all of them give rise to ocular signs and symptoms. The diagnosis is difficult in all types and most often is not made until after rupture and death. Arteriosclerosis, trauma, and syphilis are the etiologic agents in most cases. Arteriovenous aneurysms, on the other hand, are relatively easily diagnosed and offer considerably more hope of repair. Exophthalmos with pulsation and bruit are the cardinal and almost constant symptoms. The therapy of choice is ligation of the common carotid artery with subsequent ligation of the internal carotid. (Bibliography of 363 references.) Morris Kaplan.

Spies, T. D., Perry, D. J., and others, **Ocular disturbances in riboflavin deficiency.** Jour. Lab. and Clin. Med., 1945, v. 30, Sept., p. 751.

The results presented are of a two-

year study of riboflavin deficiency conducted in the Nutrition Clinic at Hillman Hospital of Birmingham, Alabama, by the Departments of Internal Medicine and Ophthalmology of the University of Cincinnati. Ninety percent of patients reporting to the clinic suffered dietary deficiency and of these 70 percent complained of visual disturbances. Five hundred eye patients were treated, of which 300 are reported in this paper. The general symptoms were nervousness, insomnia, headache, burning and aching of legs and feet, burning and cramping of stomach, constipation, burning of the skin, and general inability to do physical work. The ocular symptoms were itching and burning of the eyes, failure of visual acuity, photophobia, lacrimation, conjunctivitis, and night blindness. Dilatation of conjunctival and corneal vessels, corneal ulceration (53 percent interstitial keratitis (60 percent) and pterygia (50 percent) were found. In spite of these signs and symptoms no pathognomonic picture of the disease could be made. The pathogenesis of the deficiency is not understood but the response to riboflavin was unmistakable. Three detailed case reports are given to show that the response to riboflavin in advanced stages of the disease was dramatic. Of the 300 patients 72 percent were able to return to work after months or years of idleness. (Bibliography.)

Morris Kaplan.

Stine, G. H., and Draper, P. **Horner's syndrome.** Rocky Mountain Med. Jour., 1945, v. 42, July, p. 504.

A review of the anatomy and the etiologic factors involved in Horner's syndrome is presented. The symptoms are described. The differential diagnosis of the spastic miosis by means of an analysis of the pupillary responses to autonomic drugs such as acetylcholine and adrenalin is presented in detail. In a man who developed the syndrome after mumps encephalitis complicated by a head injury, the instillation of adrenalin was followed by a temporary recovery. The lesion was postganglionic, probably the result of a thrombosis of the internal carotid artery. Morris Kaplan.

Taylor, W. O. G., and Fergusson, A. G. **Dermatitis from wearing Army spectacles.** Brit. Med. Jour., 1945, July 14, p. 40.

Six cases of dermatitis are presented. The British Army spectacle frames are made of nickel silver, which is an alloy of nickel, copper, and zinc and is plated with nickel. In each case the dermatitis commenced promptly upon wearing the glasses, occurred in the areas of contact with the frames and healed promptly after removal of the glasses or a change of the frame. It was concluded that the dermatitis was an allergic reaction to ionized nickel which was freed by electrolysis in the presence of acid sweat aided by the body heat. Morris Kaplan.

Valenta, A. **Sudden bilateral blindness of luetic origin.** Klin. M. f. Augenh., 1942, v. 108, May-June, p. 339.

A 53-year-old male lost vision in both eyes within 24 hours. Only a slight remnant of light perception was left which was completely lost two days later. Pupils were wide and inactive, but both eyes were otherwise normal. Neurologic examination and roentgenograms were negative. The Wassermann reaction in blood and

spinal fluid was strongly positive. Two days later bilateral papillitis developed with retinal hemorrhages in the left eye. Antisyphilitic treatment and vitamin-B injections were started immediately. Sixteen days after the onset of the blindness light perception returned and nine days later fingers could be counted. Optic atrophy developed. Subsequent improvement of functions could not be followed up since the patient withdrew from further observation. It might be asumed that a gumma had formed in the chiasm, or that a nonspecific agent had caused a transverse optic neuritis in the body which had been rendered less resistant by the chronic infectious syphilitic process.

F. Nelson.

18

HYGIENE, SOCIOLOGY, EDUCATION, AND HISTORY

Boshoff, P. H. **Blindness and diseases of the eye in South Africa.** South African Med. Jour., 1945, v. 19, May 12, p. 148.

In 1938 the ratio of blind per 100,000 in the United States was 51.8 while in South Africa it was 400 for the nation and reached 2,000 in some districts. He states the amount of money spent for pensions in a rather makeshift system of registration and insists that if some of that money were used to subsidize well-trained ophthalmologists who would practice among the natives, the figures of blindness could be greatly reduced. The plea continues for postgraduate ophthalmologic facilities in their two medical schools, since no such facilities exist in the entire nation.

Morris Kaplan.

Bücklers, M. **Ophthalmologic race hygiene according to Lisch.** Klin. M. f. Augenh., 1942, v. 108, March-April, pp. 155-160.

Apparently Lisch expressed some extreme views on the subject. Bücklers criticizes him most scornfully and analyzes the individual case histories which Lisch used as illustrations. (References.

F. Herbert Haessler.

Chenoweth, C. **Rehabilitation of the deaf and blind.** Jour. Iowa State Med. Soc., 1945, v. 35, Oct., p. 392.

The newly blinded casualty is assured a psychologic and emotional support by special consultant at the first hospital of residence. A temporary training program is arranged to bridge the time until the newly blinded soldier is sent to one of two special centers. At the center the soldier is taught how to dress and shave, how to feed and care for himself. He is taught the use of a typewriter. The talking book and radio offer much enjoyment before he learns Braille. Occupational therapists teach him to use his hands, to develop new skills and dexterity and thus assist in restoring confidence through useful work. When the patient has learned to get about readily he is encouraged to enlarge his social contacts.

Experience shows that only ten percent of the blind can use Seeing Eye dogs advantageously. Many blinded soldiers will develop the ability to get about inconspicuously with a minimum of assistance and a skillfully used cane.

Following the initial training, the direction of schooling depends greatly on a patient's native ability, intelligence, and past education. The government will send any blind man through college who is able to qualify.

Theodore M. Shapira.

Cowen, J. P. **Optical service units of the Navy.** War Med., 1945, v. 8, July, p. 18.

The two types of optical units used by the Navy are described. The large, permanent-base type, and the smaller, semipermanent mobile type. By their use the supplying, replacing, and repairing of spectacles has been carried directly to personnel in the field. They do no examining or treating but satisfactorily produce the average, single-vision spectacles required by the Navy. Morris Kaplan.

Eames, T. H. **Eyes of premature children.** Amer. Jour. Ophth., 1946, v 29, Jan., pp. 57-63.

Feiman, E. M. **Rehabilitation of the blind.** Indust. Med., 1945, v. 14, Aug., p. 649.

In the Timken Roller Bearing Company of Canton, Ohio, totally blind employees check bearings which must be accurately ground to one twenty-five millionth of an inch. These bearings are checked in an electronic device which for the sighted operator automatically switches on lights of various colors to denote under, over, or acceptable dimensions. For the blind operators, the company invented a sound detector, which emits notes of different pitch from a small speaker mounted on the back of the chair of the operator. The Timken Company offers this apparatus without royalties to any industry willing to employ the blind for such work.

Morris Kaplan.

Gasteiger, H. **Sterilization of individuals with hereditary cataract.** Klin. M. f. Augenh., 1942, v. 108, March-April, pp. 161-166.

Gasteiger discusses the law which relates to sterilization and the pertinent ophthalmologic data which concern the inheritance of cataract and the amenability to treatment of hereditary forms. He believes the practice of the majority of oculists is sound; namely, to refrain from sterilization of patients with uncomplicated, hereditary cataract and good surgical prognosis. (References.) F. Herbert Haessler.

Gradle, Harry. **Graduate training in ophthalmology.** Jackson Memorial lecture. Trans. Amer. Acad. of Ophth. and Otolaryng., 1945, Sept.-Oct., pp. 10-13. (See Amer. Jour. Ophth., 1946, v. 29, Jan., pp. 24-28.)

Hardy, L. H., and Rand, G. **Elementary illumination for the ophthalmologist.** Sight-Saving Rev., 1945, v. 75, Spring, p. 30.

A guide is presented for the ophthalmologist who might be called upon to conduct a survey of existing lighting or to advise for lighting to be installed. A complete definition of terms is followed by a discussion of principles on which judgment may be based. These principles include intensity, quality, contrast, distribution, and glare. An easily comprehended practical discussion of fluorescent lighting is also included.

Morris Kaplan.

Keller, P. **Blindness in Tonkin.** Arch. d'Opht., 1941-42, no. 3-4, v. 4, p. 101.

Visitors to Indo-China are struck by the frequency of blindness among the seven million inhabitants of Tonkin, but no statistics as to cause and frequency have been available. Keller, who is director of the Ophthalmological Institute of Hanoi, has analyzed the findings in 14,000 patients drawn from

a population of approximately 100,000. The gonococcus proved to be the principal cause of blindness and the author has outlined a detailed plan of prophylaxis whereby each case of purulent ophthalmia could be detected early and treatment started. Other causes of blindness are analyzed in chart form and the total number of totally blind in the province is estimated to be 22,470 with 30,030 blind in one eye.

Phillips Thygeson.

Kranz. H. W. **Indications for sterilization of individuals with cataract.** Klin. M. f. Augenh., 1942, v. 108, March-April, pp. 145-155.

Kranz, not an ophthalmologist but director of the University Institute for race hygiene at Giessen, outlines the principle which underlies a decision to bring about sterilization of an imperfect individual. He discusses each type of cataract and points out that less than ten percent justify sterilization.

F. Herbert Haessler.

Lueck, I. B. **Vision in industry.** Amer. Jour. Ophth., 1946, v. 29, Jan., pp. 63-72.

New, G. B. **The fiftieth anniversary of the Academy. Address of the president.** Trans. Amer. Acad. of Ophth. and Otolaryng., 1945, Sept.-Oct., pp. 7-9.

Since April 1896, when Dr. Hal Foster organized the first meeting of the Academy, until the present, the membership has increased from a very small group to 3,700. The many advantages which the Academy offers its members are discussed in detail, and the numerous forms of instruction which are presented, including motion pictures, are discussed at some length. The advances which have been made during the war will be reflected in future programs and will assure even greater interest and educational value than in the past.

Chas. A. Bahn.

Pepper, O. H. P. **Modification of a blood pressure apparatus for use by the blind.** Arch. of Ophth, 1945, v. 34, Aug., pp. 113.

This is a description of an apparatus developed by J. O. Kleber of the American Foundation for the Blind. It consists of a modification of the Tycos spring sphygmomanometer with a plastic bristle and elevated pegs so that the instrument may be used by the blind. Two illustrations.

John C. Long.

Polack. **Tscherning and his work.** Annales d'Ocul., 1940. v. 177, May, pp. 179-187.

Tscherning died on September 1, 1939, the day of the beginning of World War II. Polack's obituary has only just become available for American readers.

Born in 1854, on a Danish island, Tscherning's early thesis on the etiology of myopia led to his appointment as Assistant Director in Javal's laboratory at Paris. He obtained his Doctorate in Medicine in 1887, with a thesis on the law of Listing; was naturalized a Frenchman, was made Chevalier de la Légion d'Honneur, and in 1910 was made Professor at the University at Copenhagen, resuming his Danish nationality. In 1890, Tscherning presented to the Société Française d'Ophtalmologie a new apparatus called "ophthalmophakometer," the purpose of which was to determine the radii of curvature of the crystalline lens, its distance from the cornea, and the form of its posterior surface. In the same year he presented a study on the in-

fluence of spherical aberration on the refraction of the eye, a subject which had not previously received attention. In 1892 he published the first results of his researches on accommodation. His lessons on physiologic optics, delivered at the Sorbonne, were published in 1898. In 1904 he presented to the International Congress of Ophthalmology the first results of his researches on color vision, in which he questioned the adequacy of Young's theory of color vision. (A 2-page chronologic list of Tscherning's works; portrait.) W. H. Crisp.

Rötth, A. de. **Analysis of 1,000 new eye patients.** Amer. Jour. Ophth., 1945, v. 28, Dec., pp. 1329-1334.

Wetzel, J. O. **Rehabilitation of the blind.** Jour. Michigan State Med. Soc., 1945, v. 44, Aug., p. 820.

The author presents his plan for the State of Michigan in the rehabilitation of the blind.

Prevention: (1) early examination and treatment; (2) sight-saving classes; (3) enforcement of safety laws under all conditions which may endanger eyesight; (4) revamping existing state laws by competent ophthalmologic authority to make eye examinations of the potentially blind obligatory.

Rehabilitation: (1) extend services to every blind person who can possibly be restored to employment; (2) extend knowledge of the great capabilities of blinded workers, properly trained, so that employers and the public will have greater confidence in them.

Theodore M. Shapira.

19

ANATOMY, EMBRYOLOGY, AND COMPARATIVE OPHTHALMOLOGY

Deringer, M. K. **The results of homoplastic, heteroplastic, and xenoplastic transplantation of the optic vesicle in Triturus and Rana.** Jour. Nat. Cancer Inst., 1945, v. 5, June, p. 437.

Experiments performed by the author confirmed the results of previous investigators that in all amphibians at the tail-bud stage the optic vesicle has complete powers of self-differentiation; that is, when it is transplanted to an unusual position, it is able to form an eye with all its characteristic parts, usually in their normal relations. Occasionally, however, various abnormal relations were established. Distortion of the retinal layer, displacement of the lens, and failure of the optic nerve to connect with the host brain were common. The abnormal relations were fewer in homo- and heteroplastic but more frequent in xenoplastic (between individuals of widely distant species) transplantation. The transplanted eyes had a normal, although slightly smaller, appearance and the optic nerves were connected with the brain. In xenoplastic transplantation the transplanted tissue became differentiated into retina and lens, but underwent degeneration and in some cases disappeared entirely.

R. Grunfeld.

NEWS ITEMS

Edited by DR. DONALD J. LYLE

904 Carew Tower, Cincinnati 2

News items should reach the editor by the twelfth of the month.

DEATHS

Dr. Theodore J. Dimitry, New Orleans, Louisiana, died October 26, 1945, aged 66 years.

Dr. Chester H. Fairchild, Woodland, California, died September 6, 1945, aged 74 years.

Dr. Benjamin W. Hazell, Baltimore, Maryland, died October 3, 1945, aged 73 years.

Dr. Alexander G. Hough, Beaver Dam, Wisconsin, died September 26, 1945, aged 75 years.

Dr. Orville K. Kaylor, Saint Louis, Missouri, died October 24, 1945, aged 72 years.

Dr. William R. Knabe, Orleans, Massachusetts, died September 10, 1945, aged 66 years.

Dr. Everett A. Land, Norfolk, Virginia, died October 30, 1945, aged 65 years.

Dr. John G. Shimmon, Cleveland, Ohio, died October 23, 1945, aged 61 years.

Dr. Leonidas M. Stokes, Walterboro, South Carolina, died September 23, 1945, aged 66 years.

Dr. Otto H. Swantusch, Angola, Indiana, died October 13, 1945, aged 61 years.

Dr. Paul Tradelius, Brooklyn, New York, died October 11, 1945, aged 71 years.

Dr. John Walter Webb, Indianapolis, Indiana, died October 9, 1945, aged 64 years.

Dr. Clyde L. Welsh, Seattle, Washington, killed in action December 15, 1944, aged 45 years.

Dr. Albert A. Yungblut, Cincinnati, Ohio, died August 21, 1945, aged 73 years.

MISCELLANEOUS

PRECEPTORSHIPS

In regard to the substitution of a preceptorship for residency in an ophthalmic hospital, the American Board of Ophthalmology has always accepted such training in favorable cases. During the present overcrowding of facilities, the Board expects to take a liberal attitude regarding the requirements for training.

It should, however, be pointed out that neither a residency nor a preceptorship suffices in itself to meet the requirements of the Board. Each case will still be judged on its merits in determining fitness for examination.

In entering upon a preceptorship certain conditions should be kept in mind. First the student will profit most after a sound course in the basic sciences of physiology of the eye and of vision, optics, pathology, bacteriology, chemistry, pharmacology, the relation of the eye to general disease, anatomy, embryology, and neurology.

This is essential for a residency, more so for a preceptorship. While men have been accepted from preceptors not diplomates of the Board, it is obvious that the Board has more information about those teachers who have passed its examinations.

Any preceptor should understand that he is assuming a responsibility in taking a student and is not merely obtaining help in the drudgery of his office. He should be willing to give time to clinical training and the use of apparatus, slitlamp, ophthalmoscope, tonometer, and to directing the student's practice in surgery on animal eyes, assisting in operations, and ultimately in performance of them.

To cover the same amount of ground will take much longer in a preceptorship than in a residency, and students should accept opportunities to take hospital positions of all sorts as they become available.

S. Judd Beach, M.D., Secretary.

Emory University will celebrate the one hundredth anniversary of the birth of Abner Wellborn Callhoun, M.D., LL.D., born April 16, 1845, died August 21, 1910, the first professor of ophthalmology of the Atlanta Medical College.

You are cordially invited to be the guest of Emory University at an Ophthalmological Seminar to be held in Atlanta on April 4, 5, and 6, 1946.

PROGRAM

Thursday evening, April 4, 1946, ACADEMY OF MEDICINE. 6:30: Buffet supper; 7:30: Dr. James Edgar Paullin, "Dedication of Auditorium;" 8:00: Dr. Frank B. Walsh, "Myasthenia gravis;" 9:00: Dr. Walter I. Lillie, "Medical ophthalmology."

Friday morning, April 5, 1946, GRADY HOSPITAL. 10:00: Dr. Walter I. Lillie, "Diplopia;" 11:00: Dr. William Benedict, "The clinical meaning of exophthalmos." Luncheon (Guest of Grady Hospital).

Friday afternoon, ACADEMY OF MEDICINE. 3:00: Dr. Derrick Vail, "Eye changes in diabetes;" 4:00: Dr. Frank B. Walsh, "Naso-pharyngeal tumors;" 6:30: Dinner, Biltmore Hotel (Guest of Emory University).

Friday evening, ACADEMY OF MEDICINE. 8:00: Dr. Parker Heath, "Ocular therapeutics in glaucoma;" 9:00: Dr. John Dunnington, "Treatment of detachment of the retina."

Saturday morning, April 6, 1946, ACADEMY OF MEDICINE. 10:00 Dr. William Benedict, "Glaucoma in diabetes;" 11:00: Dr. John Dunnington, "Surgical treatment of the vertical deviations." Luncheon, Biltmore Hotel (Guest of Department of Ophthalmology).

Saturday afternoon, ACADEMY OF MEDICINE. 2:30: Dr. Parker Heath, "Random notes on ocular surgery;" 3:30: Dr. Frank B. Walsh, "Ocular signs of subdural hematoma;" 4:30: Dr. Walter I. Lillie, "The clinical diagnosis of retrobulbar neuritis."

Saturday evening, ACADEMY OF MEDICINE. 8:00: Dr. William Benedict, "Preparation of the patient for

cataract operation;" 9:00: Dr. Derrick Vail, "The circulation of the optic nerve and its influence on disease." Dr. Eugene Stead, Dean, 50 Armstrong Street, S.E., Altanta, Georgia.

The University of Glasgow, Department of Ophthalmology, announces the following series of spring meetings:

During April and May a series of meetings will be held in the Department on Wednesdays at 8:00 P.M. The general arrangements will be similar to the series held last year. Tea will be served after the paper and a discussion will follow. The meetings will be open to all medical practitioners and senior students interested in Ophthalmology.

April 3d, "Industrial ophthalmology," by Prof. W. J. B. Riddell.

April 10th, "Keratoconjunctivitis," by Dr. I. C. Michaelson.

April 17th, "Concussion injuries of the retina," by Dr. A. M. Wright Thomson.

April 24th, "Ocular tuberculosis," by Professor Lowenstein.

May 1st, "Ocular vitamin deficiency," by Dr. J. D. Fraser.

May 8th, "Capillary fragility," by Dr. H. N. Munro.

All cases of legal blindness in New York State must be reported to the Commission for the Blind of the State Department of Social Welfare in accordance with a recent amendment to the act creating the New York State Commission for the Blind. It is now the duty of every health and social agency, attending or consulting physician, or nurse to report to the State Commission for the Blind, in writing, the name, age, and residence of persons who are blind within the definition of blindness and to furnish such additional information as the Commission shall request for registration or prevention of blindness.

This law supplements the mandated responsibility of the Commission for the Blind, Section 8774, Title 24, Chapter 3 of the Unconsolidated Laws to maintain a complete register of the blind in the State of New York which shall describe the conditions, cause of blindness, capacity for education, and industrial training of each, with such other facts as may seem to the Commission to be of value.

Data as required by the Commission for the Blind will further the State's effort to prevent blindness through a comprehensive knowledge of the facts relative to the causes of blindness. This information will also aid in the earlier recognition and detection of cases where remedial measures for restoration of vision are still possible. Likewise, those who may desire the services of the Commission for the Blind will be benefited through acquaintance with the opportunities available to which they are entitled.

Legal blindness is defined as total blindness or impaired vision of not more than 20/200 visual acuity in the better eye and for whom a diagnosis and medical findings show that vision cannot be improved to better than 20/200; or who has loss of vision due wholly or in part to impairment of field vision or to other factors which affect the usefulness of vision to a like degree.

Apparent blindness should also be reported even though not based on an eye examination.

For reporting blanks, please address the Commission for the Blind, 205 East 42d Street, New York 17, New York.

The following resident lectures in ophthalmology were held in New York City in February, 1946: at the Manhattan Eye, Ear, and Throat Hospital on February 1st and 8th: "Sulfonamides in ophthalmology," by Dr. L. Von Sallmann; "Allergy in ophthalmology," by Dr. Robert Cooke. At the New York Hospital on February 15th and 22d: "Syphilis of the eye and its treatment," by Dr. Walsh McDermott; "Local anesthesia in ophthalmology," by Dr. Walter S. Atkinson.

American Orthoptic Council

Examinations for Technicians

The next examination by the American Orthoptic Council will be held in September-October, 1946.

The written examinations will be held at various cities in the country on Friday, September 6, 1946. Only those passing the written examinations will be permitted to take the oral and practical tests, to be given in Chicago, Saturday, October 12, 1946.

Applications on official forms must be received before July 1, 1946.

Address the American Orthoptic Council, 23 East 79th Street, New York 21, New York.

It has been announced recently that the Helen Keller Committee on the Deaf-Blind has been formed as a department of the American Foundation for the Blind, 15 West 16th Street, New York 11, New York. The committee has the following objectives: (1) To improve educational methods for the deaf-blind on an individual basis to provide greater self-resourcefulness, thus compensating for limited contacts with others. (2) To find a shorter and more rapid manual language to speed communication with family and friends. (3) To obtain greater vocational opportunities for the deaf-blind in workshops for the blind and in private industry. (4) To increase the social relationships of the deaf-blind by developing special activities for them and by devising ways to permit them to participate in usual recreations.

Societies

The annual two-day meeting of the Pennsylvania Academy of Ophthalmology and Otolaryngology will be held at the Merion Golf Club outside of Philadelphia on Wednesday and Thursday, April 24 and 25, 1946. For detailed information address: Dr. Paul C. Craig, 232 North Fifth Street, Reading, Pennsylvania.

Personals

Dr. Brittain Ford Payne has resumed the practice of ophthalmology, by appointment, at 17 East 72d Street, New York 21, New York.

Dr. L. Conner Moss announces the reopening of his office at 1705 Rhode Island Avenue, N.W., Washington, D.C., specializing in ophthalmology.

Drs. Trygve Gundersen and Joseph M. Clough announce their return to the practice of ophthalmology at 101 Bay State Road, Boston 15, Massachusetts.

Dr. Arthur M. Culler announces his return to the private practice of ophthalmology in the offices formerly occupied by Dr. Albert D. Frost at 150 East Broad Street, Columbus 15, Ohio.

Dr. M. W. Nugent has returned to the private practice of ophthalmology at 1930 Wilshire Boulevard, Los Angeles 5, California.

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